DOCUMENT RESUME

ED 152 518	SE 023 950

TITLE	Environmental Quality, the Sixth Annual Report of the Council on Environmental Quality.
INSTITUTION	Council on Environmental Quality, Washington, D.C.
PUB DATE	Dec 75
NOTE	800p.; Not available in hard copy due to marginal legibility of original document
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock Number 040-000-00337-1, $6.60)
EDRS PRICE	MF-$1.50 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	Annual Reports; Economics; *Energy; *Environment; *Federal Government; Federal Legislation; Land Use; *Natural Resources; *Pollution; Public Health; Quality Control
IDENTIFIERS	Council on Environmental Quality

ABSTRACT

This sixth annual report discusses the state of the environment and progress accomplished in meeting the goals and objectives established for an improved environment. Each of the seven chapters deals with an important environmental parameter. Chapter one is devoted to carcinogens in the environment. Chapter two presents perspectives on the environment and discusses the current problems associated with air, water, noise, solid wastes, hazardous substances, energy, coastal zones, water resources and public lands. Environmental conditions, trends and economics are explored in chapters three and four. International activities are reported in chapter five. The sixth chapter reviews the effects of the National Environmental Policy Act especially as it relates to the requirements for environmental impact statements. The final chapter describes the studies being conducted by the Council on Environmental Quality. (CS)

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THE SIXTH ANNUAL REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY

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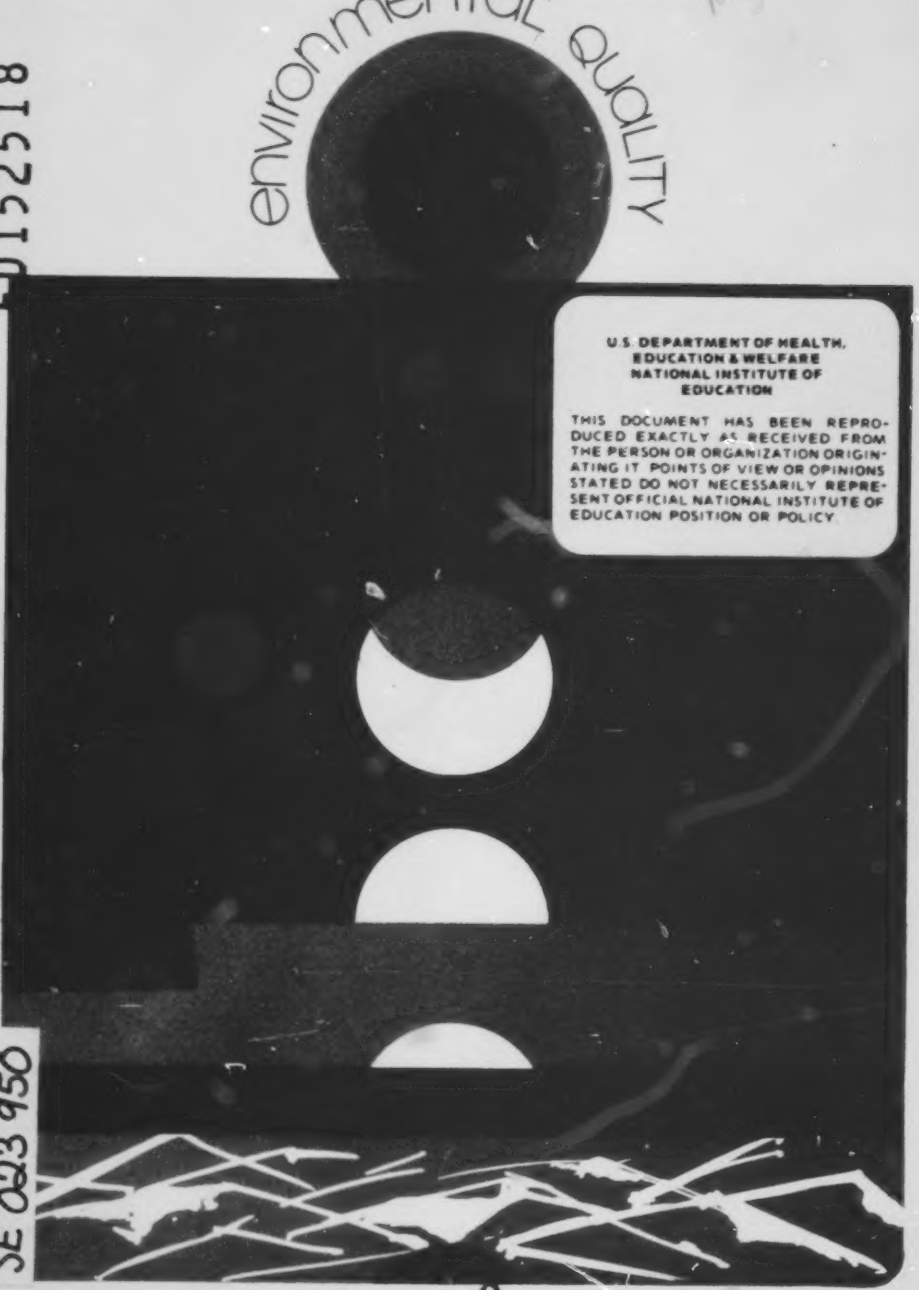
ENVIRONMENTAL QUALITY



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PUBLICATIONS OF THE COUNCIL ON ENVIRONMENTAL QUALITY:*

Environmental Quality—The First Annual Report of the Council on Environmental Quality

Ocean Dumping—A National Policy

The President's 1971 Environmental Program

Toxic Substances

Environmental Quality—The Second Annual Report of the Council on Environmental Quality

The President's 1972 Environmental Program

Environmental Quality—The Third Annual Report of the Council on Environmental Quality

Integrated Pest Management

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The Federal Environmental Monitoring Directory

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Environmental Quality—The Fourth Annual Report of the Council on Environmental Quality

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Land Use, reprinted from the Fifth Annual Report of the Council on Environmental Quality

MERES and the Evaluation of Energy Alternatives

The Delaware River Basin—An Environmental Assessment of Three Centuries of Change

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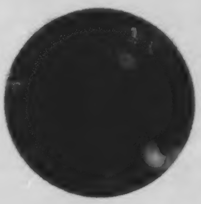
THE SIXTH ANNUAL REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY

environmental quality



DECEMBER 1975

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THE PRESIDENT'S MESSAGE

To the Congress of the United States:

It is a measure of our progress as a Nation that today, in the 200th year of American Independence, we are in the midst of a dynamic movement to restore, protect, and preserve our environment and, at the same time, make the most effective use of our natural resources—with the objective of providing a better life for ourselves and for our children and grandchildren.

This society has come a long way since the time when the daily struggle with climate and wilderness dominated our ancestors' lives, challenged their spirit and energies, and shaped attitudes that served so well to forge a new Nation. We have learned that our past progress was often achieved without adequate regard for the longer-term consequences to our air, water, and land. Some have concluded from our past experiences that certain national objectives—such as a strong economy, an adequate supply of energy, and an improved environment—are in conflict and we must choose among them. Others are concluding—and I share their view—that we can make good progress toward all these objectives if our goals are realistic, our resolve is firm, and our steps are deliberate.

The Sixth Annual Report of the Council on Environmental Quality which I am forwarding to the Congress surveys our environmental accomplishments and indicates that we have made much progress indeed.

The Council's summary of environmental conditions and trends describes the encouraging results of our efforts to clean up the air and water. We are beginning to bring our most chronic sources of water pollution under control, and we are improving the quality of some of our most heavily polluted waterways. We have improved air quality significantly in the United States during the past five years.

The progress we have made so far is in large measure a reflection of the investment the Nation has made in cleaning up the environment. In 1975 government and industry spent more than $15 billion in capital and operating expenditures to meet the requirements of Federal pollution control legislation. The Federal Government alone has increased its pollution control outlays from $751 million in 1970 to an estimated $4.5 billion in the current fiscal year. Over the next ten years the Nation will spend more than $22 billion per year to meet Federal pollution control requirements.

We can be proud of the progress we have made in improving the Nation's environmental quality. Yet, we must meet additional challenges over the next few years. We must improve our understanding of the effects of pollutants and of the means and costs of reducing pollution. As we develop new energy sources and technologies, we must assure that they meet environmental standards. We also must continue the job of cleaning up pollution from existing sources.

The Council has reviewed the environmental conditions of our coastal zone and on Federal public lands and describes the diverse purposes they serve and the variety of ways in which our people can use and enjoy them. Because of the competing demands upon these areas, we will face a continuing challenge in assuring their best uses and in providing protection of their environmental values.

International activities over the past year have provided a helpful perspective for understanding the global scope of many environmental issues. Our community of nations is beginning to come to grips with this reality and, through the United Nations Earthwatch Program, is making a major attempt to monitor environmental conditions and trends throughout the world.

Our experience and our growing knowledge about the scientific, technical, and economic aspects of environmental effects and controls have given us a basis for considering "mid-course corrections" in existing environmental laws. The attention now being given in the Congress and the Administration to a review of the requirements of the Clean Air Act and the Water Pollution Control Act are important examples of this new level of awareness.

In these and other efforts, we must set our goals carefully, pursue them vigorously, and maintain the balance among our national objectives. This is essential if we are to enjoy the continued public support for our environmental objectives that is necessary to future progress.

We have made an excellent start. I am confident we shall continue in this vital area.

GERALD R. FORD.

The WHITE HOUSE,

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
722 JACKSON PLACE, N. W.
WASHINGTON, D. C. 20006

LETTER OF TRANSMITTAL

THE PRESIDENT:

Sir: The Council on Environmental Quality herewith submits its sixth Annual Environmental Quality Report, December 1975, in accordance with Section 201 of the National Environmental Policy Act of 1969 (42 U.S.C. 4341).

Respectfully,

Russell W. Peterson
Russell W. Peterson
Chairman

John A. Busterud
John A. Busterud

Beatrice E. Willard
Beatrice E. Willard

HIGHLIGHTS

Chapter 1 CARCINOGENS IN THE ENVIRONMENT

- About 2 million chemical compounds are known, and each year thousands more are discovered by the U.S. chemical industry and hundreds are introduced commercially. We know very little about the possible health consequences of these new compounds. Many are not toxic, but the sheer number of chemical compounds, the diversity of their use, and the adverse effects already encountered from some make it increasingly probable that chemical contaminants in our environment have become a significant determinant of human health and life expectancy. (p. 12)

- The economic and social impacts of cancer in the United States are massive. An estimated $1.8 billion per year is spent solely for hospital care of cancer patients. Additional costs, doctor bills, outpatient therapy, and other treatment-related fees, raise the direct expenditures for cancer well into the tens of billions of dollars. (p. 12)

- [T]he rate of lung cancer among U.S. males is five times that for females. Among women the leading form is breast cancer. (pp. 15–16)

- It is estimated that 60 to 90 percent of all cancer is related to environmental factors. They include, among others, the large component of lung cancer attributable to cigarette smoking, exposures to chemicals in the workplace, and cancers from natural agents such as solar and cosmic radiation, natural asbestos, and aflatoxins (a class of chemicals secreted by some molds). (p. 17)

- The majority of known environmental carcinogens are encountered at the workplace. In fact, the link between cancer and chemicals was first detected among workers; in 1775, soot was singled out as a causative agent in chimney sweeps' cancer, cancer of the scrotum. (p. 23)

- Some chemicals are virtually everywhere in the environment, but at low concentrations—a combination of circumstances which presents formidable problems of safety assessment for investigators. It will be extremely difficult, for example, to assess the carcinogenic impact of the pesticide aldrin/dieldrin because . . . residues are found in 99 percent of the U.S. population. (p. 28)

- The validity of applying animal test results to man is firmly based upon empirical evidence. Not only have rodent experiments given positive carcinogenic test results for compounds known to cause cancer in man, but also—in every case except arsenic—each chemical known to cause cancer in man has been found to do so in animal species. (p. 30)

- The greatest improvement in survival rates for most types of cancer occurred between the 1940's and 1950's probably because of advances in detection, treatment, and surgical technique . . . Although continued progress has been registered for several types of cancer since the 1950's, 3-year survival rates for others stubbornly resist change. (p. 35)
- Cancer has a long latency period. In humans there is usually a 15- to 40-year lag between cause and effects. There is no indication that long-term exposure to carcinogens is necessary to produce cancer. Although increased levels of exposure to a carcinogen carry with them an increased risk of developing cancer, a single exposure to a chemical may also result in a cancer. (p. 38)
- With only modest recent improvements in cancer therapy, the only prudent policy toward cancer is to increase the emphasis on prevention. Prevention entails identification of cancer risks prior to human exposure. Scientist policymakers are relying on laboratory experiments, principally upon animals, to evaluate the cancer risk and to develop public health policies. (pp. 38–39)

Chapter 2 PERSPECTIVES ON THE ENVIRONMENT

Air

- On May 30, 1975, EPA['s] latest assessment of compliance . . . showed that SO_2 had been reduced 25 percent nationwide. . . . Particulates, the other main pollutant from stationary sources, had been cut by 14 percent. Of the approximately 20,000 major stationary sources, 15,600 had either met the standards or had a schedule for doing so. (p. 45)
- The debate resulted in a November 1974 decision by the Administration to permit use of intermittent controls by some isolated existing rural powerplants up to but not later than 1985, but in the meantime they must meet ambient air quality standards through intermittent control systems. Powerplants are required to sign a compliance schedule for installing permanent controls consistent with the availability of scrubbers and with the reliability of power generation. (p. 47)
- The [Supreme] Court held that . . . the chief responsibility for attainment of ambient air standards rests with the states. So long as a state's control strategy achieves and maintains ambient air standards, the Court ruled, EPA cannot interfere with the state's timing or its enforcement techniques. (p. 49)
- A major auto-related air pollution event of the past year was EPA's finding that catalytic converters (fitted with air pumps) can discharge sulfuric acid mists and sulphates at levels significantly higher than uncontrolled automobiles and that these emissions could create a health problem under extreme conditions. (p. 52)

Water

- By July 1 of this year, over 40,000 permits had been issued . . . . The emphasis was on "major" industrial and municipal discharges, with 95 percent of these applications processed. (p. 65)
- By the end of fiscal year 1975, approximately $6.6 billion of [municipal waste water treatment] funds had been obligated and $1 billion actually spent. [T]he annual obligations are increasing, and the total $18 billion authorization is expected to be obligated by September 1977. . . . By

the end of fiscal year 1977, an estimated 1,500 projects will be complete, with 4,785 additional projects under construction and 3,800 still in the first and second stages. (p. 68)

- The data on project grants . . . indicate clearly that the 1977 statutory deadline for installing secondary treatment will not be met [by municipal dischargers]. (p. 71)
- In a 1974 survey, the states identified $342 billion in "needs" for waste water control facilities. Two-thirds ($235 billion) of these funds would be used for controlling storm water discharges. . . . With only approximately $12 billion of federal aid remaining available, the fundamental question is how the money should be allocated to achieve the most improvement in water quality. (p. 74)
- The National Commission on Water Quality has awarded over $11 million for more than 100 studies pertaining to both the 1977 and 1983 requirements of the legislation. (p. 75)
- [I]n 1974 ocean dumping increased almost 20 percent. Sewage sludge and construction and demolition debris were the materials primarily making up the increase . . . . New York and Philadelphia account for most of the sludge dumping . . . . (p. 78)

Noise

- Neither existing FAA regulations nor proposed EPA regulations submitted to FAA for publication and consideration under the Noise Control Act would prohibit the presently planned fleet of 16 Concordes from flying over the United States at subsonic speeds and landing at U.S. airports. (p. 88)
- OSHA published proposed regulations on October 24, 1974, with a 90-decibel 8-hour limit and a 5-decibel halving rate, recognizing that comparatively more workers would be at lower risk at 85 dBA than at 90 dBA but stating that economic impact and technical feasibility problems, as reflected in that draft environment impact statement, justified keeping the level at 90 dBA. (p. 89)

Solid Wastes

- The recycling boom of the early 1970's appeared to be over and many volunteer recycling centers went out of business. (p. 93)
- In the short run, the past year was a major setback for recycling and recovery, but the prospects for long-run progress are promising in view of the basic economic pressures associated with the costs of virgin materials, energy, and land. (p. 94)
- Legislation banning or taxing nonreturnable beverage containers . . . has been introduced in 50 state Legislatures and numerous county and city councils since 1971. As of mid-1975, three states, Oregon, Vermont, and South Dakota, had laws restricting beer and soft drink containers, and one, Minnesota, had a law affecting all major types of packaging wastes. (p. 96)

Hazardous Pollutants

- Scientific evidence first published in June 1974 suggested that fluorocarbon releases may eventually affect the protective ozone layer in the stratosphere and thereby allow increased harmful solar radiation to reach the surface of the earth. Fluorocarbons are the propellants in about half of all aerosol cans and are the principal fluids used in refrigerators and air conditioner coils. (p. 104)

- In the summer of 1974 articles in the press about possible chemical contamination of drinking water in New Orleans and other cities caused some alarm. EPA then began a survey of water supplies in 80 cities. Preliminary results, published in April 1975, confirmed widespread low-level contamination . . . . (p. 106)
- [M]any chemicals that present major environmental problems escape government regulation almost entirely. There are no statutes under which PCB's may be restricted to uses that do not threaten the environment. . . . Similarly, should it prove necessary to regulate fluorocarbons, there are no federal laws covering commercial and industrial use. (pp. 107–108)

Energy

- While the U.S. population has grown by more than one-third since 1950, total energy use doubled. Energy consumption grew at an average annual rate of about 3.5 percent from 1950 to 1965 and then accelerated to a 4.5 percent rate until the 1973 oil embargo. In contrast, domestic production grew at an annual rate of only 3 percent between 1950 and 1970 but has shown little or no growth since then. (p. 109)
- To reduce consumption and conserve energy, the President's proposals relied heavily on higher imported and domestic oil prices combined with voluntary conservation efforts. The Congress, while advocating energy conservation, espoused direct regulatory actions and specifically dismissed substantial energy price increases. (p. 114)
- A major initial task of ERDA was preparation of a national plan for energy research and development. . . . The plan's primary purpose was to facilitate the shift from dependence on diminishing resources to reliance on less limited or unlimited resources. In the short term (to 1985), research is generally related to enhanced recovery of oil and gas and to deployment of conventional nuclear reactors. In the midterm (to 2000), existing liquid and gaseous fuels would be replaced by synthetics and less conventional energy sources such as solar and geothermal. In the long term, the plan looks to an all-electric society. (p. 116)
- Accelerated [OCS] leasing grew increasingly controversial. Public and Congressional concern centers on the enviromental impacts, both offshore and onshore, of oil and gas production and whether OCS generated revenues should be shared with the states. (p. 118)
- A moratorium on additional leasing of federal coal, formally in effect since 1973, was continued in 1975 while the Interior Department developed a new leasing strategy. . . . Much of Interior's effort during the past year focused on environmental impact assessment. (p. 122)
- Over the past several years environmental problems associated with nuclear power centered on reactor technology—on radiation standards, plant siting and safety, and thermal effluents. Attention is now focused more on the nuclear fuel cycle, and issues associated with the fuel cycle will remain important. (p. 127)
- Of the many new technologies currently being examined, the one nearest to contributing meaningfully to our energy supply is the solar heating and cooling of buildings. (p. 134)

Coastal Zone

- Concern for the coastal environment marked the public debate on OCS development in frontier areas. . . . [L]eaders in the states and cities near the new areas raised objections to leasing unless their concerns were adequately addressed. . . . Plans devised to meet the concerns of the coastal states included the idea of separating decisions to lease and explore on OCS tracts from decisions to produce. (pp. 144–45)

- Long in advance of production, then, there are increased demands on community services. Whether these demands prove negligible or burdensome depends to a large degree on the character of a community. (p. 146)
- [I]t is not impossible to win community acceptance of new refineries. Economics and experience are strong determining factors. Communities where jobs are scarce, especially cities and towns with industrial experience, are likely to approve refinery applications. Approval is much less likely in pastoral places where fishing or farming is thriving, or in vacation areas, or in prosperous white collar towns. (pp. 152–53)
- Whether through a change in the law or a revision of the rules by the Interior Department, a process for a more detailed review of development plans after discovery appeared certain. The main purpose of this new process would be to permit a joint review by federal, state, and local authorities of plans to develop the oil. The best time to plan for the onshore impacts of oil development is at this point—after exploration has shown where the oil is and how much is there. (p. 160)
- As coastal zone management programs evolve, they are bringing into prominence two important questions. One has to do with levels of government—the relations between nation and state and between states and localities. . . . The other not entirely separate question is that of economic growth and its relation to environmental protection. (p. 161)

Land Use

- Recent analysis by the Bureau of the Census shows that since 1970, metropolitan areas have grown at a slower rate than nonmetropolitan counties. (p. 166)
- The data show that the unexpected growth in nonmetropolitan counties is occurring in the nonfarm segment of rural areas and in small cities and towns; farm population continues to decline. (p. 167)
- [T]he National League of Cities at its 1974 national convention . . . adopted a new policy of "urban conservation," urging cities to take advantage of their existing physical resources to give a sense of history, character, and individuality to revitalization efforts. (p. 168)
- [T]he 1973 Highway Act allows highway funds to be transferred to transit projects, both from interstate segments and from other urban highway projects. Complex regulations and disagreement among jurisdictions have inhibited transfer of interstate highway funds to mass transit. So far only Boston, Philadelphia, and Washington have substituted mass transit for interstate highway projects. . . . New York and East St. Louis, Illinois, are the only cities that have successfully transferred non-interstate federal urban highway funds from highway projects to transit projects. (pp. 174–75)
- A number of communities are moving ahead with a combined program of land use designation and compensation for the rights taken. (p. 183)

Water Resources

- The Flood Disaster Protection Act of 1973 increased previous limits of flood insurance coverage while making future federal financial assistance (including most bank loans) in identified flood hazard areas contingent upon participation of the community in the [National Flood Insurance Program]. Although many communities have qualified for the program, some have objected to the act's required community flood plain development standards. (p. 201)

- The Corps of Engineers as well as other federal agencies and national environmental organizations actively support full consideration of nonstructural alternatives, which could provide flood-prone communities with long-term benefits of flood damage reduction, open space for public recreation, and protection and enhancement of natural ecosystems, often at lower costs to the federal government than equivalent structural measures. (p. 202)
- The environmental impacts of several more traditional federal flood control projects were the subject of extensive study and public debate during the past year. . . . After reviewing the results of this study, on July 31, 1975, the Governors of the four DRBC states voted 3 to 1 to ask the Congress not to appropriate funds for construction of the [Tocks Island] dam. (p. 202)
- The channelization of streams for flood control and improved drainage continues to draw criticism, primarily for its adverse environmental effects. However, the SCS has recently improved project planning and environmental assessment procedures to consider more systematically the environmental effects of and alternatives to stream channelization. Some proposed channel work has been dropped from project plans or scaled down to clearing debris from existing streambeds and floodways. (p. 204)
- The prospects of coal conversion, including electric power generation, gasification, and liquefaction, and the processing of oil shale on a large scale in water-short areas of the Western United States raise a significant issue of competition with existing agricultural and municipal uses. (p. 208)

Public Lands

- Grazing is a very old use of the public land and is an important one economically. Thirty-one percent of the nation's rangeland—about 373 million acres—is on public lands. . . . Eighty-three percent of the grazing lands in the public domain managed by BLM is in fair, poor, or bad condition. The 50 million acres in poor or bad condition equals in land area the state of Utah. . . . Much of the range in the National Forests could produce more forage. (pp. 212–14)
- BLM [is taking] corrective action in managing its grazing lands to include more supervision of range use—for example, enforcement of compliance with grazing plans and control of livestock trespass; adjustment of the number grazing to range capacity; a realistic apportionment of the forage requirements of wildlife, wild horses, and burros; and consideration of environmental impacts of competing land uses. (pp. 216–17)
- The need to protect wildlife as well as watershed and other values on rangelands under BLM management points up the necessity for explicit legislative authority for BLM to manage its lands for multiple purposes. (p. 220)
- Eighteen percent—some 92 million acres—of all the nation's commercial forest land is held in the National Forests. How this substantial holding is managed has a considerable effect on overall timber supplies. (p. 222)
- Private forest landowners may use intensive forestry methods to hasten and increase output, but intelligent environmental safeguards should be applied. Public ownership of the National Forests offers the chance to manage an important share of the nation's timberland in a way reflecting

consideration of other forest values and uses that is not often possible by private owners. Moreover, by law the public lands must be managed to meet a broad array of public objectives and goals. (p. 224)

- Managing all the resources on our public lands presents common problems of conflicts among uses and users. Mining has a special problem as well. The laws that govern it—the Mining Law of 1872 and the Mineral Leasing Act of 1920—in effect limit the federal government's control over mineral development on the land that it owns. (p. 230)
- The General Accounting Office July 1974 report on the 1872 Mining Law posed the questions of whether the law encourages development of mineral resources, results in effective management and use of the land, protects the environment, and responds adequately to shortages of domestically produced mineral ores. In the course of the study, GAO visited 240 mining claims and 93 patents issued within the last 25 years in four Western states (Arizona, California, Colorado, and Wyoming). In 239 of 240 no mining was taking place, and on 237 there was no evidence that it ever had. There was no evidence that minerals had ever been extracted on 74 of the 93 patents. (p. 234)
- National Park Service policy has now restored preservation of natural and historic features to first place. In recent years the Service has recommended large amounts of parkland for preservation as wilderness. The parks will of course still welcome visitors, but accommodations will be planned with preservation in mind. (p. 240)
- For a long time the public has been concerned about the power of private concessions' supplying food, lodging, gas, and souvenirs in National Parks. . . . The purpose of concessions is to provide the services that visitors need, not to exploit the parks for commercial interests. (p. 247)
- Altogether, Wilderness Areas in 1975 amounted to 12.7 million acres, which is 2 percent of our public lands and 0.5 percent of all the land in the United States. . . . If the Congress adopts all the Administration's proposals, there will be nearly 40 million acres of wilderness permanently protected. Besides that, there is 35.5 million acres more which is slated for review. . . . (pp. 251–53)
- In spite of intense interest and activity by the public and the public lands agencies over the past 10 years, the major decisions on how much permanent wilderness we need still lie before us. At a generous estimate, over 200 million acres of land is still suitable for wilderness designation. (p. 255)
- Wildlife management has developed largely in response to interests of hunters and fishermen. Although public concern with wildlife that is neither hunted nor fished has grown, the narrow focus on game persists. (p. 262)

Chapter 3 ENVIRONMENTAL CONDITIONS AND TRENDS

Air Quality

- The Clean Air Amendments of 1970 set mid-1975 as the deadline for achieving public health (primary) standards for ambient air quality. Although air quality in the United States is better today than it was in 1970, the deadline was not fully met, and air pollution levels at many locations still range above the primary standards. (p. 299)
- Between 1940 and 1970, the total nationwide emissions of all the major regulated air pollutants grew substantially—controllable particulate emissions increased about 15 percent, sulfur dioxide increased about 50 per-

cent, carbon monoxide and hydrocarbon emissions more than doubled, and nitrogen oxide emissions quadrupled. Since 1970, however, air pollution control programs appear to be stemming that growth. The estimated total nationwide emissions of particulates and carbon monoxide have been reduced significantly, and the other major regulated pollutants have remained near 1970 levels. [B]etween 1970 and 1974, particulate emissions dropped about 29 percent, sulfur dioxide declined 8 percent, carbon monoxide dropped 12 percent, and hydrocarbon emissions declined about 5 percent. On the other hand, nitrogen oxide emissions have increased an estimated 10 percent over the same period. (p. 305)

- In 1973 . . . the primary (public health) annual standard for suspended particulate levels was still being exceded at 26 percent or 521 of the 2,024 monitoring stations reporting a full year's valid data, and the secondary annual standard—designated for protection of vegetation, materials, and other environmental values—was being exceeded at 49 percent or 996 of the 2,024 sites. Preliminary data for 1974 indicate improvements to 21 percent for the primary and 43 percent for the secondary standards. (p. 312)
- Between 1970 and 1973, the nationwide quarterly average for suspended particulate levels declined about 14 percent. Since then it appears to have leveled off somewhat. (p. 314)
- Of all the regulated major air pollutants, sulfur dioxide has improved the most . . . . By 1973, the annual average and maximum daily primary standards for sulfur dioxide were being exceeded at only 3 and 5 percent of the reporting stations, respectively. Preliminary 1974 data are similar. . . . The national average sulfur dioxide levels dropped 25 percent from 1970 to 1974. (pp. 316–18)
- The 1-hour ambient standard for carbon monoxide is exceeded at only about one-tenth of the monitoring sites that report data to EPA, but violations of the 8-hour standard are widespread. In 1973, 72 percent of the same reporting stations exceeded the 8-hour standard, although the preliminary 1974 data show a reduction to 64 percent. (p. 318)
- Until recently, ozone and other oxidants were generally considered an air pollution problem only for the large urban areas. . . . But during the past few years, oxidant levels exceeding the 1-hour ambient standard were found in some rural areas, far from any cities or other known major sources of hydrocarbon or nitrogen oxide emissions. (p. 322)
- It is becoming increasingly evident that the air pollutants upon which our standards and monitoring have been focusing do not represent all the important parameters of air quality. In some cases, they may not even represent the most important or informative ones. (p. 326)
- [T]he particulate sulfate levels observed at 164 urban NASN sites were highest in the Northeast. Findings were similar at 25 nonurban sites, but urban sulfate concentrations were substantially higher than nonurban. Only in rural areas of the Western states were sulfate levels near the average global background range of 1–2 micrograms per cubic meter. . . . [S]ince the late 1950's, particulate sulfate levels have remained fairly constant in spite of the reductions observed in sulfur dioxide levels over that period. (p. 327)
- [A]verage levels of organic particulates dropped about 55 percent between 1960 and 1970. . . . This improvement has apparently resulted from the reduced use of coal for residential space heating as well as from better control of open burning in dumps and coal refuse piles. (p. 335)

- Ambient monitoring must provide a great deal of the information that is needed to guide the nation's efforts to improve air quality. . . . By far, the most critical need for improving that information is better quality control in the processes by which air monitoring data are acquired and handled. (p. 336)

Water Quality

- It is clear that our efforts to restore and protect our nation's waters have made some encouraging progress. The water quality indicators, trend anaylses, and studies all show that many of the worst point sources of pollution are being effectively controlled and that some of our most heavily polluted waterways are being cleaned up. These same evaluations also clearly indicate that nutrients, trace metals, and land runoff are going to present difficult and persistent challenges to the national commitment to improving water quality. (p. 362)
- [T]he composite frequency of violation of aquatic life protection criteria . . . shows a reduction . . . . [T]he proportion of stations in the very poor and severe categories (60 percent or more of all measurements in violation) dropped from 16 to 3 percent over these years, and no stations were in the severe category in 1974. . . . The improvements in drinking water suitability as measured by this indicator are even more pronounced than those seen for aquatic life. (p. 352)
- [M]ost lakes studied in the Eastern states are suffering some degree of accelerated eutrophication. This condition is primarily attributed to the nutrients, often phosphorus, that drain from agricultural and urban land, although industrial effluents and municipal sewage treatment plants also contribute. . . . For most of the problem lakes, stemming accelerated eutrophication would appear to require control of nonpoint sources. (pp. 355–58)

Hazardous Pollutants

- Water samples indicate that the total pesticide content of U.S. surface waters fell off sharply between 1964 and 1968. Specifically, a preliminary analysis of available water quality data for 1970–74 shows a continuous decline in DDT levels consistent with the trend in domestic consumption . . . . Because of distortions, however, the data are not statistically significant at this time. (pp. 370–71)
- Restrictions on DDT use have brought about significantly lower measured DDT levels in wildlife and in human food supplies. There has been a consistent but more gradual decline of DDT residues in human beings. Soils have shown, if not a decline, at least a stabilization of DDT levels. (p. 375)
- Because of evidence that aldrin/dieldrin is carcinogenic, human exposure levels are of great concern. . . . The incidence of detectable aldrin, which is quickly degraded to dieldrin, has declined from 5.6 percent of all food samples in 1965 to virtually none since 1972. Incidence of dieldrin has increased, but the average dieldrin level declined, offsetting the increase. (pp. 379–80)
- Because there are no data available for the period since September 1974, when most aldrin/dieldrin uses were banned, the effects of the ban cannot yet be assessed. . . . Current evidence seems to indicate that levels of dietary intake will decline fairly rapidly as direct application to foodstuffs stops. (pp. 381–82)

- Data for Great Lakes fish have been collected since 1972. Because declines of DDT and mercury levels have been observed following control programs, investigators expected that PCB contamination levels would also begin to decline by now. Yet the sparse data collected so far show a disconcerting pattern of static or rising PCB levels. (p. 386)
- The total input of PCB's into the oceans of North America has been calculated at about 3.3 million pounds and for DDT at about 110 million pounds. Yet samplings in the North Atlantic indicate that PCB residue levels in the water are at least as high as those of DDT, despite the much greater load of DDT discharges. The implication is that PCB's are even more persistent in ocean water than long-lasting DDT. (pp. 387–88)
- PCB's were recognized as a problem so recently that the monitoring data collected in the few years since 1970 give only a crude idea of what to expect in the future. How they behave in the environment—how they are degraded, for example, or how they are transported—is still uncertain. Efforts to eliminate release of PCB's to the environment have not been entirely successful. (p. 391)
- [N]ot enough data have been gathered to permit the discovery of general trends [but] there is evidence that the natural recycling of mercury is a long-term legacy of trouble from uncontrolled discharges in the past. Nationally, levels of mercury in fresh water appear unchanged since 1970, . . . but the experiences of selected areas are divergent. (p. 395)
- Mercury contamination and cleanup measures are both quickly reflected in marine invertebrates. Since 1970, significant declines in the total mercury burden of coastal organisms have been observed in at least two sites. (p. 399)
- Curtailment of agricultural uses of mercurial biocides appears to have limited the sources of mercury pollution in meat and poultry. Most of the mercury pollution in food occurs in fish and shellfish. . . . [O]ther sources of mercury—air, water, consumer products, medicinals—also have a bearing on total human exposure. (p. 400)
- Man's use of mercury has a long history of impacts on the distribution of mercury to the environment, even to the Arctic. Our understanding and control of the complex cycling of mercury in the environment are largely incomplete. (p. 400)

Living Resources

- By intense commercial fishing . . . man has seriously reduced populations of some of the most plentiful fishes off U.S. coasts. (p. 400)
- [T]he annual harvest stabilized at about 60,000 tons between the late 1930's and the mid-1960's. Foreign fishermen then happened upon the haddock. . . . The 1965 harvest peaked at 165,000 tons, and within 2 years the population declined sharply. (p. 403)
- Yellowtail flounder, halibut, and bluefin tuna are also depleted stocks. Levels of several other populations are at about one-half those of the early 1960's. Foreign fleets are focusing mostly on mackerel and squid, but the incidental catches of overfished species continue to impede their recovery. (p. 404)
- For every class of animals surveyed by the Department of the Interior's Office of Endangered Species, approximately 1 out of every 10 species native to the United States may be endangered or threatened. . . . With disturbing similarity, recent findings indicate that of all higher

plants native to the continental United States, including Alaska, more than 1 out of 10 may be endangered, threatened with becoming endangered, or recently extinct. (p. 408)

Population

- During the past year the U.S. population increased by about 1.6 million, passing the 213 million mark in February 1975. The population growth rate for 1974 increased to 0.75 percent from 0.71 percent in 1973. (p. 418)
- In the United States, the total fertility rate rapidly declined from a peak of 3.7 in the late 1950's and is now below the replacement level. . . . For the last 3 years the rate has continued to drop; it was 2.02 in 1972, 1.90 in 1973 and 1.86 in 1974. Even with these reduced fertility rates, the number of births increased in 1974 because there were more women in their reproductive years . . . . (p. 419)
- In 1967, more than one woman in four in the prime childbearing years expected to have four or more children; by 1974 only one young woman in ten expected to have so many. (p. 420)
- [P]rojections show that if the United States were to maintain a total fertility rate of 2.7 (the level in 1966), the population would be about half again greater 50 years from now than if the total fertility rate were 1.7. . . . The difference of 132 million people has substantial implications in terms of resource consumption, environmental stress, and the general quality of life. (p. 423)

Energy Technology

- Section 11 of the Federal Nonnuclear Energy Research and Development Act of 1974 directed the Council on Environmental Quality to report annually on the probable environmental consequences of trends in the development and application of energy technologies. This section is CEQ's first such report. (p. 427)
- To forecast the impacts of any energy program, whether resource development or research and development, three projections must be made:

  Primary environmental impacts, that is, the air and water emissions, the solid wastes, the land requirements of a plant or process, and effects on ecosystems of the area

  The economics of the plant or process

  Secondary environmental impacts of the development—impacts from associated industries, employment, population shifts, housing, public and commercial services and social changes. (p. 428)
- Considered by themselves, the new technologies do not present a complete picture. . . . In many cases the synthetic fuel is only an intermediate product that must be further refined or converted before it is ready for final use. Thus, entire chains comprised of links—such as coal extraction, gasification, and transmission—must be considered in comparing the environmental profiles of new energy systems. (p. 432)
- The induced activity causes additional direct environmental impacts . . . . [T]he population influx may create greater land use impacts and place higher demands on public services than the energy facility that began the process. (p. 436)

Chapter 4 ENVIRONMENTAL ECONOMICS

- Our present pollution control policies are attempting to reduce substantially damage and avoidance costs by increasing abatement and transactions costs. From the strict viewpoint of economic efficiency, the goal of our environmental policies should be to minimize the sum of the four types of costs . . . . (p. 495)
- The damage functions are determined by two primary factors. The first is how the amount of damage to each person, plant, animal, building, etc. is related to the amount of pollution. The second is how many people or things are exposed to the pollution. (p. 516)
- [R]eal investment (in pollution abatement by industries) increased 365 percent from 1967 to 1974 while dollar expenditures increased 550 percent. . . . [R]eal investment appears to have decreased slightly between 1973 and 1974. (p. 521)
- The share of [industrial] plant and equipment investment devoted to pollution abatement has generally risen, but the increases were neither continuous nor rapid. Indeed, in several sectors there have been periods of net decrease or leveling off, particularly between 1973 and 1974. (p. 521)
- The water pollution control grants program is the second largest federal public works program (highways are first), and it may soon become the largest capital expenditure item in local government budgets. . . . The largest portion of current federal spending for pollution abatement is given as grants to other levels of government. About 10 percent is directed to reducing pollution from federal facilities. (p. 525)
- The cost of building treatment plants has increased even faster than most other costs. As a result, annual waste water treatment investments increased only 40 percent in real terms between 1967 and 1973 while increasing 128 percent in dollar terms. (p. 529)
- [Incremental pollution abatement costs are estimated at $217.7 billion from 1974 through 1983. I]ndustrial air pollution abatement costs have increased noticeably but mobile source costs have fallen. . . . Estimates for industrial water pollution control have increased substantially . . . , but projected municipal waste water expenditures are slightly lower. . . . [C]osts for noise regulations show a substantial drop as a result of new information provided by EPA. Air pollution investment costs are expected to reach a peak during the years 1975 to 1977, and water pollution investments are expected to rise steadily through the decade, reaching a peak in 1983. (p. 532)
- These costs average out to approximately $47 per capita for 1974. For the median income family, pollution abatement costs will rise to about 2.5 percent of gross family income in 1983 before the ratio begins to decline again. (p. 533)
- [T]he 1975 incremental cost estimates are $22.9 billion higher than the 1974 estimates, but just adjusting last year's estimates for inflation between 1973 and 1974 would account for approximately $20 billion of this increase. Adding 1983 and removing 1973 from the estimate also adds approximately $29 billion, so that the real costs for the years 1974 through 1982 are actually lower this year than last. Reduced O&M costs (because of a slower rate of investment) and reduced mobile source costs account for most of this drop. (p. 563)

- [A]ll the analyses seem to indicate that [environmental programs] have on net probably increased, not decreased, the number of available jobs. This is so because of expenditures stimulated by the air and water pollution control deadlines and by the municipal grants program. Construction of sewers and sewage treatment plants, for instance, is relatively labor intensive. (p. 533)
- CEQ/EPA-sponsored analyses also indicate that the demands for pollution control investments will not seriously disrupt capital markets or displace significant amounts of investment for capital expansion . . . . (p. 539)

Chapter 5 A GLOBAL ENVIRONMENT

- In the developing world, where nearly three-quarters of the earth's people live, adequate food for growing populations is seen as the overriding environmental problem. (p. 571)
- Never in history has there been assurance of enough food for all the world's people. But despite great expansions of world food production, the situation today is in some ways more critical than ever. The Food and Agriculture Organization of the United Nations reckoned that in 1970 at least 400 million people (excluding Communist Asia) were suffering serious food deficiency. (p. 572)
- Only truly remarkable improvements in agriculture have enabled food output to keep pace with the number of new mouths to feed. Yet the danger that population growth will outstrip food production remains. (p. 575)
- The best long-run solution to the problem of world hunger has three parts—control of population growth, economic development to provide people with enough income to buy an adequate diet, and development aid to raise food production in poor countries. (p. 578)
- Altogether, poor countries in the developing world cultivate about twice as much land as rich countries—but produce 20 percent less food. Improving yields appears to be the best hope for most of these countries. (p. 580)
- One-fourth of the people who have ever lived since prehistory are alive today. The human population reached 4 billion in 1975[;] the number of young people approaching childbearing age will cause [it] to grow to 6.5 or 7 billion by the year 2000. (pp. 591–92)
- The world harvest of finfish, reflecting more nations fishing, more boats, and more efficient fishing technology, jumped from 21 million tons in 1950 to 64 million tons in 1970. Afterward the catch declined; by 1973 it had dropped to 59 million tons. A 25-year trend of steadily increasing catches has reversed. (p. 598)
- The biggest accidental spill on record resulted from the breakup of the supertanker *Torrey Canyon* off Cornwall. The ship spilled all her cargo—120,000 tons—fouling 250 miles of English and French seacoast. It would take more than 40 *Torrey Canyon* spills to equal the estimated volume of oil pollution each year. (p. 600)
- It is encouraging to note that the Convention on International Trade in Endangered Species of Wild Fauna and Flora, negotiated in February 1973, has been signed by 57 nations and ratified by 16. It entered into force on July 1, 1975. (p. 615)

- Oxygen- and nutrient-rich ocean waters from the Arctic and Antarctic are essential to many fisheries in distant parts of the world. Both polar regions may now be threatened by proposals to begin or accelerate exploitation of their living and nonliving resources. (p. 616)

Chapter 6 THE NATIONAL ENVIRONMENTAL POLICY ACT

- The EIS itself is intended to be, and often is, the tip of an iceberg, the visible evidence of an underlying planning and decisionmaking process that is usually unnoticed by the public. (p. 628)
- Properly conceived and written, the EIS is an extremely useful management tool. But too many statements have been deadly, voluminous, and obscure and lacked the necessary analysis and synthesis. They have often been inordinately long, with too much space devoted to unnecessary description rather than to analysis of impacts and alternatives. (p. 632)
- Estimated NEPA-related costs are . . . relatively small compared to annual budgets or to the costs of major construction or licensing projects. For example, the Corps of Engineers estimates that in fiscal year 1974 it spent about $21.9 million on NEPA, which is approximately 1.25 percent of its annual operating budget. (p. 635)
- Recent decisions of courts of appeals for six circuits provide the beginning of a useful legal framework for determining the scope of a program environmental impact statements. (p. 641)
- The contradictory interpretations of *Conservation Society* resulted in confusion nationally about the role of state highway departments in FHWA NEPA compliance. To resolve this confusion, the Congress adopted the first amendment to NEPA. (p. 647)
- On June 24, 1975, the Supreme Court handed down its first major NEPA decision in *Aberdeen and Rockfish Railroad* v. *Students Challenging Regulatory Agency Procedures*. (p. 650)
- Since our compilation of state environmental impact statement requirements a year ago, one additional state, New York, passed an environmental conservation act and several states amended their environmental laws or executive orders. (p. 651)
- In most federal agencies effective implementation of NEPA depends on the extent to which managers at all levels—particularly the top—accept environmental analysis as a management tool to achieve the act's substantive goals. (pp. 654–55)

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CHAPTER 1

CARCINOGENS IN THE ENVIRONMENT

In the 15th century, human life expectancy was 30 years.[1] Such a statement must seem puzzling at best to the educated 20th century American and, at worst, preposterous. Recorded human history takes us back to 3000 B.C. and in every age describes the deeds of great warriors, scholars, kings, patriots, and poets. A few notable figures gained the pinnacle of success early and died early, Alexander the Great at 33, John Keats at 25. Nevertheless, the great majority of eminent humans seems to have survived to mature years—to have enjoyed a lifespan roughly equal to that of the U.S. citizen born today.

But history can be deceptive. Precisely because it focuses on extraordinary achievement, and hence on those who lived long enough to exercise their unusual gifts in a memorable way, history tends to be silent about those who died young. A critical aspect of our experience as a species is lost to our common consciousness and can be retrieved only by inquiring into the seemingly peripheral details of famous lives.

Thomas Jefferson had six children; two survived and Mrs. Jefferson died shortly after the sixth child was born. John Milton lost his only son in infancy, and his first two wives died from the rigors of childbirth. Napoleon was a fourth child; two of his older siblings died before his birth. According to a UN study of gravestones and other records, the average married Frenchman of the 17th century:

- Had only one living grandparent at birth
- Had four brothers and sisters

- Lost one of his parents by the time he was 15
- Lost two or three of his brothers and sisters by the time he married, at 27
- Lived through two or three famines, three or four near-famines, and two or three major epidemics (in addition to semipermanent epidemics of whooping cough, scarlet fever, and diphtheria)
- Died at 52.[2]

Despite the Old Testament's allotment to man of threescore years and ten, therefore, the actual attainment of such longevity is for the most part a modern triumph. As recently as 1900, a female in our country could expect to live only 48 years, a male, 46.[3]

The increase in life expectancy in this century stems, of course, from the adoption of public health measures, improvements in medicine, and heightened agricultural productivity. Recent water and sewage sanitation has eliminated the epidemics of typhoid fever and cholera that were widespread in the 19th century. Famine has never been a factor in life expectancy in the United States, and such medical discoveries as antibiotics have reduced the incidence of communicable diseases, except for influenza and pneumonia, to statistical insignificance in terms of life expectancy.

And yet within the last 20 years, a striking phenomenon stands out from the mortality tables—despite a continued decline in the rate of

Bubonic plague, for which treatment was limited to bleeding and purges, killed about one-fourth of England's population in 1348.

infant death, the average length of life has leveled off. Simultaneously, heart disease and cancer, which were responsible for only 8 percent and 4 percent, respectively, of deaths in the United States during the early part of the century, now cause more than half of our mortality.[4] It is particularly disconcerting that these phenomena occur despite unprecedented investments in medical research and health care. Moreover, death rates from cancer and heart disease, the two leading killers, have been rising rapidly.

This chapter concerns cancer. It discusses several probable causes but focuses on one, the chemicals introduced into our environment by our consumption pattern and way of life. It describes cancer (not one disease, but a family of them), considers the special problems of diagnosis occasioned by the latency-period characteristic of cancer. It analyzes the difficulty of screening cancer-causing agents (carcinogens) before approving them for mass production and distribution, and cites current efforts to improve methods for testing potentially hazardous substances. It concludes by arguing that prevention rather than treatment offers the most effective attack on cancer today.

U.S. HEALTH TRENDS

Human life expectancy and general health conditions prevailing in developed countries such as the United States represent a striking—and comparatively recent—improvement over those that characterized most of man's long history. Prehistoric man's constant quest for food was often unsuccessful; hunger and starvation, coupled with predations by animals, the natural elements, and uncontrolled disease, killed most humans before adolescence.

With the long, slow evolution of agriculture and animal domestication, man became less and less dependent on far-ranging searches for food. Even today, however, despite the spread of modern agricultural practices, high fertility rates in some developing countries regularly exceed gains in agricultural productivity, so that food shortages continue to shorten life expectancy in much of the world.

In the United States, a shortage of food has never had a major impact on life expectancy. Instances of hunger and malnutrition do exist; the fact that such instances are statistically minor in comparison with our total population does not excuse their persistence in a wealthy, food-abundant nation. In the context of world history, however, the United States has always been fortunate with respect to food; almost from the nation's earliest days, the development of a strong agricultural base eliminated starvation as a major cause of death. Throughout the 19th century, the prime life-limiting factor in this country was infectious disease.

LIFE EXPECTANCY

Perhaps because our memories are short, most of us are unaware of the remarkable contribution that public health measures and medicine have made to human longevity in the United States since 1900. A male born in Massachusetts in 1850 had a life expectancy of 38.3 years, a female, of 40.5 years. As the decades passed, life expectancy at birth inched upward—by 1880 a male could expect to live 41.7 and a female 43.5 years, by 1890 life expectancy was 42.5 and 44.5, respectively, and in the next decade for males it rose to 46 years and for females to nearly 50, at 49.4 years.[5]

Comparable data for other states apparently do not exist for the years prior to 1900, when 10 states joined in a "birth and death registration area" to collect vital statistics with reasonable national validity. Inasmuch as Massachusetts data for 1900 correlate closely with those of states from the registration area for 1900, however, we may assume that the Massachusetts statistics provide a reliable picture of gains in longevity for the nation from 1850 to 1900. During that half century, life expectancy for U.S. citizens rose about 9 years.[6]

In the next half century, by contrast, life expectancy for U.S. citizens rose 22 years. By 1973, average longevity for whites was 72 years, up from 48 in 1900; for nonwhites, average longevity stood at 66 years, doubling from only 33 years at the turn of the century (see Figure 1).[7]

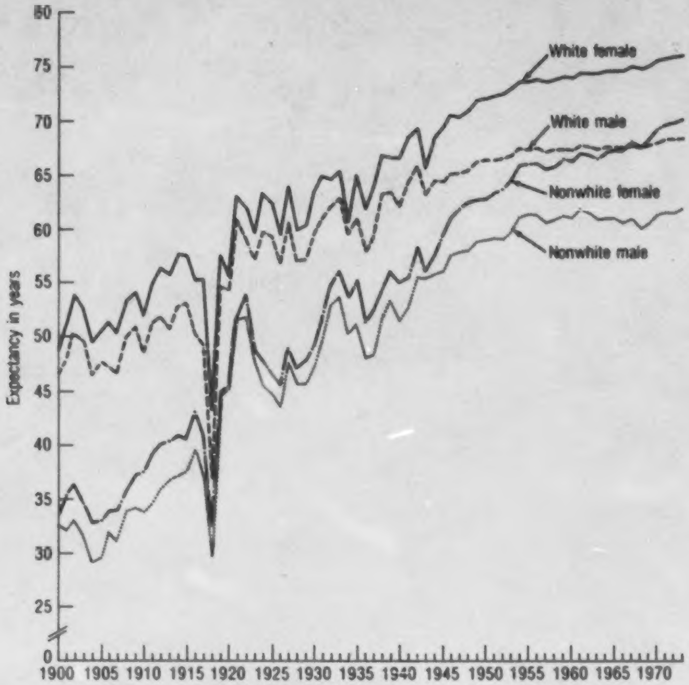
The principal factor in this increased longevity was a sharp reduction in infant mortality, shown in Figure 2, brought about by improved sanitation, health care, and the development of antibiotics. Between 1935 and 1972, the death rate for white infants dropped 68.6 percent, from 51.9 deaths per 1,000 to 16.3. Deaths among nonwhite infants showed a similar decline, 65.1 percent, from 83.7 per 1,000 live births in 1935 to 29 in 1972.[6] The resulting increase in life expectancy for individuals who survived early infancy is illustrated in Table 1.

It is important to note that most of these improvements in life expectancy occurred early in the century. By the early 1950's the decline in the infant death rate had slowed and the average length of life had leveled off. Except for the influenza year of 1918, mortality rates (adjusted for the general aging of the population) declined steadily from 1900 to 1954; they have since stabilized.

Infant death rates continued to improve between the mid-1950's and the 1960's, but less rapidly than before. In fact, of the 10 largest metropolitan areas, only Los Angeles's and Houston's were lower in 1961 than in 1950, and in six of these areas infant death rates actually increased.

Figure 1

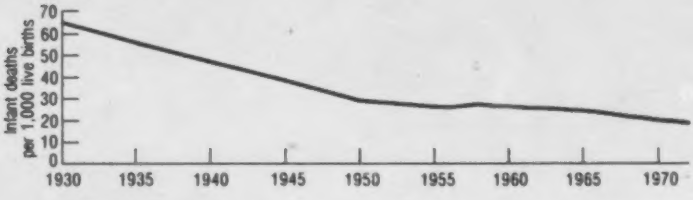
Estimated Average Length of Life, in Years, by Color and Sex, United States, 1900-73



Source: U.S. Center for Health Statistics, *Vital Statistics of the United States, 1973*, Vol. II, Sec. 5: *Life Tables*, DHEW Pub. No. (HRA) 75-1104 (Washington, D.C.: Government Printing Office, 1975), Table 5-4.

Figure 2

Infant Mortality Rates, 1930-72



Source: Department of Health, Education, and Welfare, *Facts of Life and Death*, DHEW Pub. No. (HRA) 74–1222 (Washington, D.C.: Government Printing Office, 1974), Figure 2.

Table 1

Life Expectancy, by Race and Sex

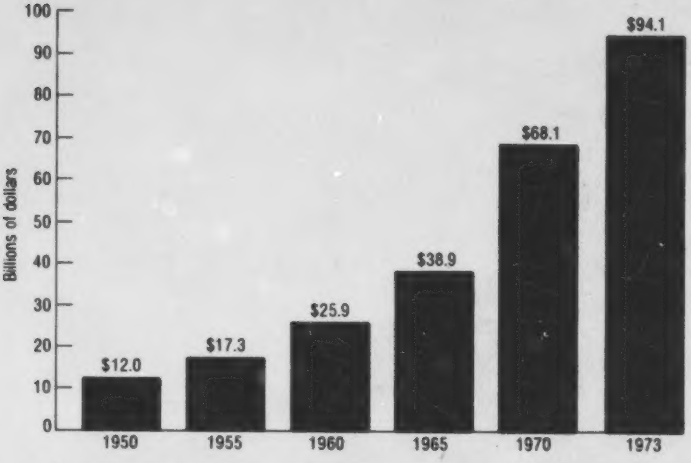
Age, color, and sex	Average number of years of life remaining								
	1973	1972	1959-61	1949-51	1939-41	1929-31	1919-21	1909-11	1909-1902
White, male									
0	68.4	68.3	67.55	66.31	62.81	59.12	56.34	50.23	48.23
15	55.1	55.0	54.93	54.18	52.33	50.39	49.74	46.91	46.25
30	41.4	41.3	40.97	40.29	38.80	37.54	37.65	34.87	34.88
45	27.8	27.6	27.34	26.87	25.87	25.28	26.00	23.86	24.21
60	16.2	16.1	16.01	15.76	15.05	14.72	15.25	13.98	14.35
75	8.1	8.1	7.92	7.77	7.17	7.02	7.30	6.75	6.34
All other, male									
0	61.9	61.5	61.48	58.91	52.33	47.55	47.14	34.05	32.54
15	49.5	49.1	50.39	48.23	43.95	39.83	41.75	36.77	38.26
30	36.7	36.4	37.05	35.31	32.25	29.45	32.51	27.33	29.25
45	24.9	24.8	24.89	23.59	22.02	20.59	23.55	18.85	20.09
60	15.6	15.6	15.29	14.91	14.38	13.15	14.74	11.67	12.62
75	9.2	9.3	8.93	8.83	8.09	6.99	7.61	6.58	6.60

White, female									
0	76.1	75.9	74.19	72.03	67.29	62.67	58.53	53.62	51.08
15	62.5	62.3	61.15	59.39	56.07	53.00	50.67	49.12	47.79
30	48.0	47.9	46.63	45.00	42.21	39.99	38.72	36.96	36.42
45	33.9	33.8	32.53	31.12	28.90	27.39	26.98	25.45	25.51
60	21.1	21.0	19.69	18.64	17.00	16.05	15.93	14.92	15.23
75	10.4	10.4	9.28	8.87	7.92	7.56	7.62	7.20	7.33
All other, female									
0	70.1	69.9	66.47	62.70	55.51	49.51	46.92	37.67	35.04
15	57.4	57.3	54.85	51.36	46.22	40.87	40.36	39.18	39.79
30	43.3	43.3	40.83	38.02	34.5[illegible]	30.67	31.48	29.61	30.70
45	30.3	30.3	28.14	26.07	24.00	21.39	22.61	20.43	21.36
60	19.3	19.4	17.83	16.95	16.14	14.22	14.69	12.78	13.60
75	11.3	11.5	10.10	10.15	9.80	8.62	8.37	7.55	7.90

Source: U.S. Center for Health Statistics, *Vital Statistics of the United States, 1973*, Vol. II, Sec. 5, "Life Tables," DHEW Pub. No. (HRA) 75-1104 (Washington, D.C.: Government Printing Office, 1975), Table 5-5.

Figure 3

National Health Expenditures Compared to Gross National Product, Fiscal Years 1950-73[1]



[1] Figures in parentheses represent percentages of GNP.

Source: U.S. Bureau of the Census, *Statistical Abstract of the United States: 1974* (Washington, D.C.: Government Printing Office, 1974), p. 69.

The leveling-off of improvement in life expectancy has occurred despite sharply increased expenditures for medical research and health care during the last 25 years (expenditures are shown in Figure 3). Per capita spending rose from $76 in 1950 to $441 in 1973.[9] In 1950, the United States invested 4.6 percent of its gross national product in health care; by 1973, the national investment in health was up to 7.7 percent of GNP—but the long, continuing improvement in U.S. life expectancy appears to have halted.[10] Have we reached the upper limits of medicine's ability to prolong human life? Or have life-limiting factors unknown in earlier decades, or of less significance then, entered in?

SHIFTS IN DISEASE PATTERNS

A comparison of leading causes of death in 1900 with those in 1960 reveals a noteworthy shift in disease patterns (see Table 2). At the turn of the century, infectious diseases—pneumonia, influenza, tuberculosis, and gastritis—were the leading killers, accounting for 31 percent of all deaths. Owing to such medical advances as the development of immunization techniques and antibiotics, tuberculosis and gastritis are no longer significant causes of death in the United

Table 2

Leading Causes of Death, 1900, 1960, and 1970

Rank	Cause of death	Deaths per 100,000 population	Percent of all deaths
	1900		
	(All causes)	(1,719)	(100)
1	Pneumonia and influenza	202.2	11.8
2	Tuberculosis (all forms)	194.4	11.3
3	Gastritis, etc	142.7	8.3
4	Diseases of the heart	137.4	8.0
5	Vascular lesions affecting the central nervous system	106.9	6.2
6	Chronic nephritis	81.0	4.7
7	All accidents [1]	72.3	4.2
8	Malignant neoplasms (cancer)	64.0	3.7
9	Certain diseases of early infancy	62.5	3.6
10	Diphtheria	40.3	2.3
	Total		64
	1960		
	(All causes)	(955)	(100)
1	Diseases of the heart	366.4	38.7
2	Malignant neoplasms (cancer)	147.4	15.6
3	Vascular lesions affecting the central nervous system	107.3	11.3
4	All accidents [2]	51.9	5.5
5	Certain diseases of early infancy	37.0	3.9
6	Pneumonia and influenza	36.0	3.5
7	General arteriosclerosis	20.3	2.1
8	Diabetes mellitus	17.1	1.8
9	Congential malformations	12.0	1.3
10	Cirrhosis of the liver	11.2	1.2
	Total		85
	1970		
	(All causes)	(945.3)	(100)
1	Diseases of heart	362.0	38.3
2	Malignant neoplasms (cancer)	162.8	17.2
3	Cerebrovascular diseases	101.9	10.8
4	Accidents	56.4	6.0
5	Influenza and pneumonia	30.9	3.3
6	Certain causes of mortality in early infancy [3]	21.3	2.2
7	Diabetes mellitus	18.9	2.0
8	Arteriosclerosis	15.6	1.6
9	Cirrhosis of the liver	15.5	1.6
10	Bronchitis, emphysema, and asthma	15.2	1.6
	Total		85

[1] Violence would add 1.4 percent; horse, vehicle, and railroad accidents provide 0.8 percent.

[2] Violence would add 1.5 percent; motor vehicle accidents provide 2.3 percent; railroad accidents provide less than 0.1 percent.

[3] Birth injuries, asphyxia, infections of newborn, ill-defined diseases, immaturity, etc.

Source: President's Science Advisory Committee Panel on Chemicals, *Chemicals and Health* (Washington, D.C.: Government Printing Office, 1973), p. 152; U.S. Department of Health, Education, and Welfare, Public Health Service, *Facts of Life and Death*, DHEW Pub. No. (HRA) 74-1222 (Washington, D.C.; Government Printing Office, 1974), p. 31.

With improved sanitation, the development of immunization techniques, and such medical discoveries as antibiotics, communicable diseases of the 19th century are insignificant as determinants of life expectancy in the United States.

States, diphtheria and typhoid fever have been nearly eliminated, and even influenza and pneumonia have declined in significance to one-seventh their previous level. A decline in the occurrence of plague, malaria, dengue fever, equine encephalitis, and several diarrheal diseases was accomplished in large part through the use of pesticides to control the rodent or insect vectors of these diseases.

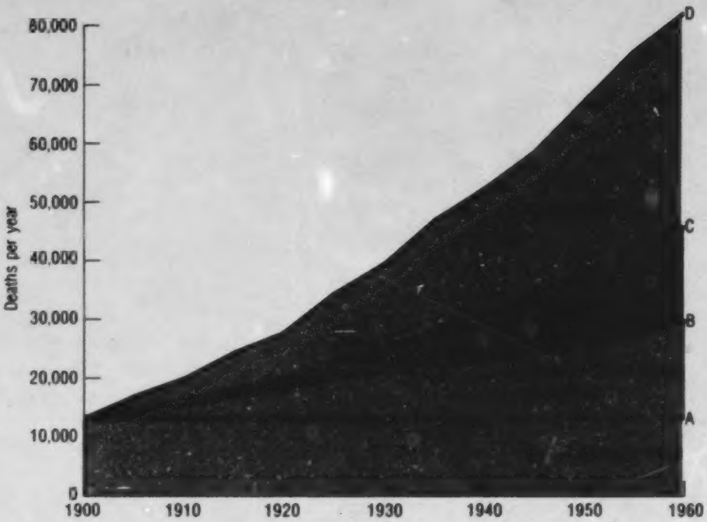
On the other hand, heart disease and cancer—the fourth and eighth leading causes of death, respectively, in 1900—now lead the list of killers. In 1900, these two diseases were responsible for 12 percent of deaths; today, they account for more than one-half of U.S. mortality. Annual rates of death from heart disease rose from 137.4 per 100,000 population in 1900 to 362 in 1970, while deaths from cancer rose from 64 per 100,000 population to 162.8.[11]

Some increase in the cancer mortality rate may have been predicted on the basis of demographic factors, such as population growth and general aging of the population, and on the success of medicine in reducing the significance of infectious diseases. Another unquantifiable portion is undoubtedly traceable to improved reporting methods, i.e., some deaths from cancer in earlier times were mistakenly ascribed to other causes. Even after these factors have been taken into account, however, the death rate for cancer sharply exceeds predictions.

Although cancer mortality information prior to 1930 is weak, a graph of the data available from the U.S. death registration area from 1900 to 1960 shows the dramatic rise. The area between lines A and C on Figure 4 illustrates the amount of increased mortality between

Figure 4

Deaths from Cancer, 1900-1960
(for U.S. Death Registration Area of 1900)



Source: J.C. Bailer, H. King, and M.J. Mason, *Cancer Rates and Risks*, DHEW Pub. No. 1148 (Washington, D.C.: Government Printing Office, 1964), p. 6.

1900 and 1960 that could be attributed to demographic factors alone. The shaded area between lines C and D is the unanticipated increase—almost equal to the predicted increase.[12]

ENVIRONMENTAL CAUSES OF DISEASE

Insidious health hazards have been introduced by people into their environment for centuries. The superbly engineered aqueducts of Rome brought the populace not only water but poisonous lead, which leached from the lead pipes into the drinking supply. Documented cases of sterility and permanent mental impairment have been traced to lead poisoning; some historians even believe that lead poisoning may have contributed to the fall of the Empire.[13] Similarly, coal-fired smog hanging above the sunless, Dickensian factory towns and big city slums of the 19th century has been linked to a hormone deficiency among children. Insufficient exposure to the sun's ultraviolet radiation, which activates the formation of the Vitamin D essential to healthy growth, is thought to have caused a widespread incidence of crippling rickets.[14] The "mad hatters" of the 19th century suffered from neurological disorders caused by inhalation of mercury used in treating furs and felts.

Thus disease caused by or associated with chemicals introduced into the environment is nothing new. In our own day, various lung diseases such as emphysema have been linked with air pollution. Oxygen transport by the blood can be impaired by nitrite—sometimes found in well water or used as a preservative in many meat products—and it can also be impaired by carbon monoxide.[15] Chemicals are believed to affect the incidence of heart disease (carbon monoxide),[16] cause permanent nerve disorders (mercury), and induce bone abnormalities (vinyl chloride).[17] A disconcerting, growing body of evidence indicates that subtle, manmade hazards are supplanting famine and infectious disease as significant determinants of life expectancy in 20th century developed nations.

Discovering links between chemicals and health problems is a slow process, usually succeeding only after a relatively long history of use or exposure. In the meantime, however, chemical development proceeds at a rapid pace. About 2 million chemical compounds are known, and each year thousands more are discovered by the U.S. chemical industry and hundreds are introduced commercially. We know very little about the possible health consequences of these new compounds. Many are not toxic, but the sheer number of chemical compounds, the diversity of their use, and the adverse effects already encountered from some make it increasingly probable that chemical contaminants in our environment have become a significant determinant of human health and life expectancy.

The remainder of this chapter focuses on the relationship of environmental factors to cancer. Cancer is not the only disease linked to the environment. It was chosen for discussion, however, because it is one of the most important, costly, and rapidly accelerating health problems in the United States. In addition, occupational and environmental cancer concerns have become increasingly prominent, particularly in the last few years.

CANCER

Cancer killed a reported 358,400 U.S. citizens in 1974.[18] About 1 million are under treatment for the disease, and each year 900,000 new cases are diagnosed. Of these, about one-third is skin cancers—troublesome, sometimes painful, but usually treatable, and with no significant impact on life expectancy; the other 600,000, however, are serious and are potentially fatal.[19] The American Cancer Society estimates that 25 percent of the 213 million people now living in the United States will ultimately develop some form of cancer.[20]

The economic and social impacts of cancer in the United States are massive. An estimated $1.8 billion per year is spent solely for hospital care of cancer patients. Additional costs, doctor bills, outpatient therapy, and other treatment-related fees, raise the direct expenditures for cancer well into the tens of billions of dollars.[21] To these direct expenditures must be added indirect costs, such as the estimated 1.8 million workyears lost to the national economy and to family income by unemployed or underemployed cancer victims.[22]

WHAT CANCER IS

Cancer is a group of diseases found in all races and ages of man and in all animal species. It may be considered a single disease only in the sense that all cancer is characterized by unrestrained growth of cells.

Most body structures are composed of tissues made up of many different types of cells, any of which may give rise to cancer. A specific type of cancer draws its name from the type of cell affected:

- Cancers in connective tissue, including bones, are called sarcomas
- Cancers in cells which line the body's internal and external surfaces (lung, breast, skin) are called carcinomas
- Cancers in cells that compose the blood-forming system are called leukemias or lymphomas.

In most cases of cancer, unrestrained cell growth leads to the buildup of tumors which compress, invade, and/or destroy normal tissues; if untreated, these tumors usually lead to death. Like cells, there are different types of tumors, each of which may be distinct in its behavior—thus affecting the course of an individual's disease. Moreover, the specific type of tumor may indicate a probable causative agent: for example, mesothelioma, a diffuse cancer of the chest or stomach lining, is associated almost exclusively with exposure to asbestos.

Malignant tumors generally share some characteristics: higher rate of cell growth than in the normal, surrounding tissues; failure to maintain the boundaries of normal tissue and organs; a microscopic appearance which suggests immature rather than mature tissues, and a tendency to spread to parts of the body distant from the original site of the cancer. Not all these features accompany every malignant tumor, but they characterize most forms of cancer.

In addition, cancers are latent diseases—there is a delay of many years between cause and manifestation of symptoms. The implications of this important characteristic are discussed later in this chapter.

Despite these similarities, there are marked differences in the occurrence of different types of cancer within human populations. The incidence of cancer varies by age, by sex, by race, by specific site or location in the body, by geographical residence, and even by ethnic or national origin.

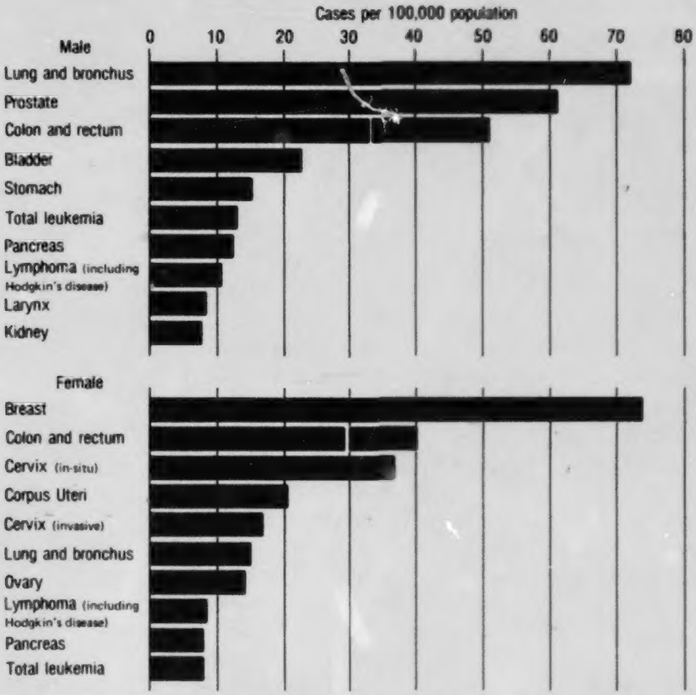
CANCER INCIDENCE

Cancer affects people of all ages but is predominantly a disease of middle and old age. Persons around age 70 account for a higher number of cases than any other age group. Cancer in women appears earlier, rising rapidly at age 20 and peaking at 60. In men cancer begins its sharp increase at 35 and peaks at 65. Between the ages of 50 and 80, men account for more cancer cases than women. After 70, the number of cases for both men and women decreases as the total population decreases.[23]

Cancer is also a significant cause of death in children. For children between the ages of 5 and 14, it ranks second only to accidents. Projections from available incidence data show that about 7,000 new cases of cancer occur annually in children under the age of 15 years.

Figure 5

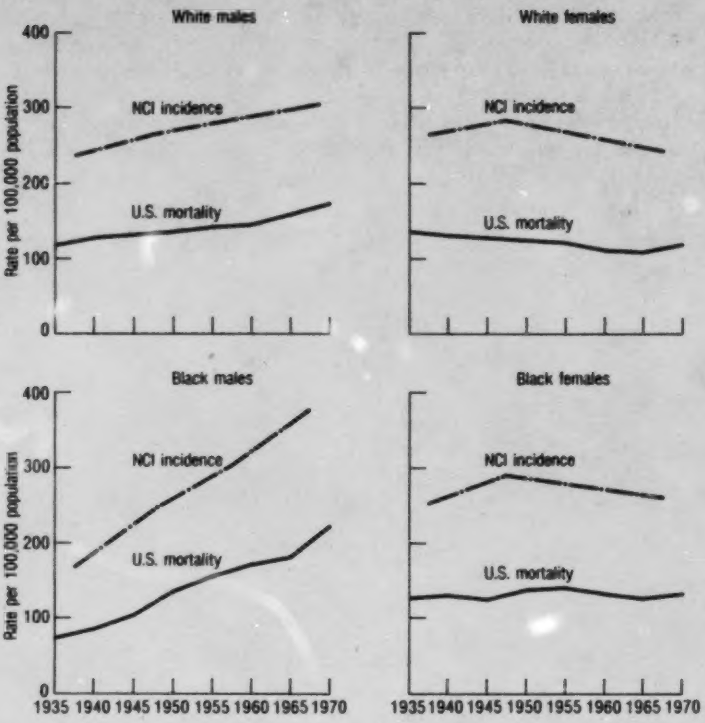
Cancer Incidence, by Site and Sex, 1969-71
(age-adjusted to 1970 U.S. population)



Source: David L. Levin et al., *Cancer Rates and Risks*, DHEW Pub. No. (NIH) 75–691 (2d ed.; Washington, D.C.: Government Printing Office, 1974), Figure 6.

Figure 6

Cancer Incidence[1] and Mortality, by Race and Sex, 1935-70
(age adjusted to 1950)



[1] Derived from the National Cancer Institute (NCI) 3rd National Cancer Survey.

Source: David L. Levin et al., *Cancer Rates and Risks*, DHEW Pub. No. (NIH) 75-691 (2d ed.; Washington, D.C.: Government Printing Office, 1974), Figure 2.

The distribution of cancer types among children is markedly different from that of the adult population. The most prevalent form of childhood cancer is leukemia, which accounts for 32.4 percent of the cases among youngsters under 5, compared to just 1 percent cancer incidence for the total population.[24]

The frequency distribution of cancer by types and body site is far from uniform; many cancer types are rare. Basal and squamous cell cancers—cancers of the skin surface—represent well over 90 percent of all skin cancers. By contrast, melanoma skin cancers, which extend from the skin to the internal organs, account for no more than 2 percent of all skin cancers.

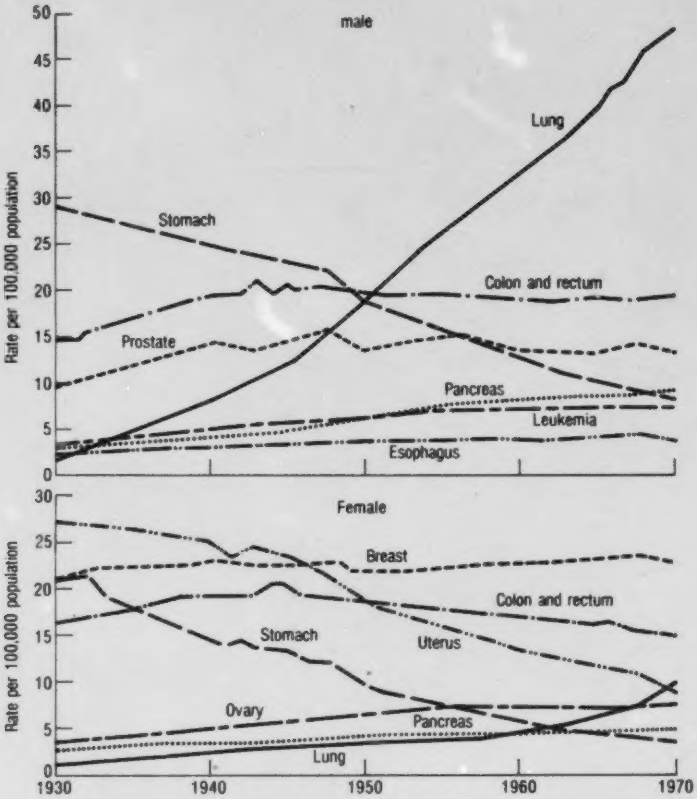
There are also marked differences in the distribution of cancer types between the sexes, as shown in Figure 5. For example, the rate of lung cancer among U.S. males is five times that for females. Among women the leading form is breast cancer.[25]

Recorded deaths from cancer in the United States have nearly doubled since 1935, from 137,649 to 337,398 in 1971. Similarly, even after taking into account demographic factors, current death rates indicate a real increase in mortality from cancer (see Figure 6). Both mortality data and surveys on incidence conducted by the National Cancer Institute point up three trends within the overall increase—a rise in cancer for white and black males, an approximately steady rate for black females, and a decline for white females.

As indicated in Figure 7, cancer incidence has remained relatively uniform for some body sites since 1930 but has changed markedly

Figure 7

Cancer Mortality Rates, by Site and Sex, 1930-70
(age-adjusted to U.S. 1940 population)



Source: David L. Levin et al., *Cancer Rates and Risks*, DHEW Pub. No. (NIH) 75–691 (2d ed: Washington, D.C.: Government Printing Office, 1974), p. 14.

for others. The most dramatic changes are the nearly twenty-fold increase in lung cancer for males, and a two-thirds decrease of stomach cancer in both males and females. The increase in lung cancer for males is primarily attributed to heavier smoking, coupled with impacts from other environmental pollutants; the stomach cancer decline is understood less, but it may be linked to diet.

CAUSES OF CANCER

Most of the details of how and why cancers develop still elude scientists and physicians, so that the exact causative factors of observed malignancies cannot be defined. But a number of factors appear to be implicated both separately and in combination for many observed cancers. Most prominent of these are hereditary factors, viruses, and environmental chemicals.

Hereditary factors, perhaps combined with chemicals or viruses, appear to be involved in a small portion of observed cancers. For example, men born with an extra X-chromosome, XXY instead of the normal XY for males, are observed to have a breast cancer rate approaching that of females, whereas normal males seldom develop breast cancer. Mongoloid children (Down's syndrome) are observed to have leukemia at eleven times the rate of normal children.[26]

The role of viruses in cancer causation is not yet well understood, although several studies suggest that Herpes viruses may be involved in certain types of vaginal cancer.[27]

It is estimated that 60 to 90 percent of all cancer is related to environmental factors.[28] They include, among others, the large component of lung cancer attributable to cigarette smoking, exposures to chemicals in the workplace, and cancers from natural agents such as solar and cosmic radiation, natural asbestos, and aflatoxins (a class of chemicals secreted by some molds).

ENVIRONMENTAL INFLUENCES

The conclusion that environmental factors are so important derives primarily from observations of extreme variation in both incidence and distribution of different kinds of cancers throughout the world—and within the United States. If one accepts the lower range of incidence observed anywhere in the world for a given cancer type as representing a natural rate for that cancer, an observed excess is logically attributed to local and regional environmental factors.[29]

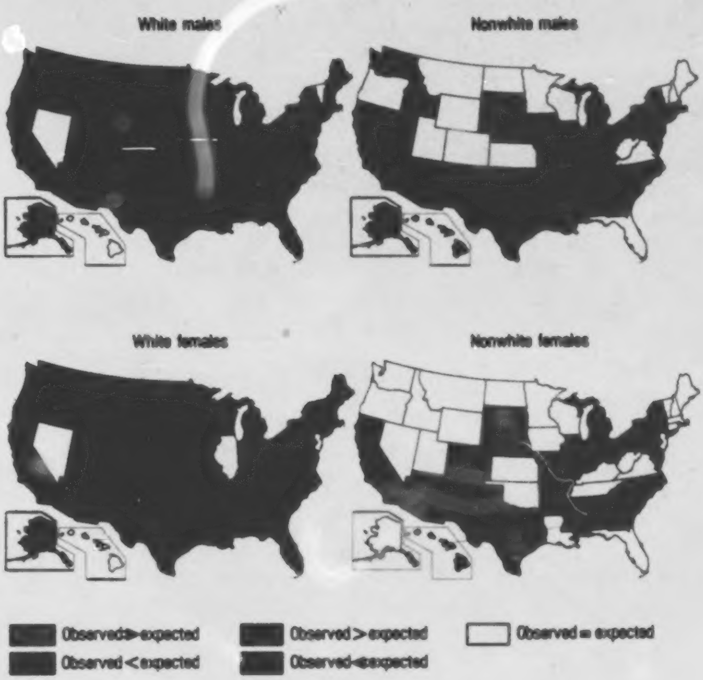
Such estimations are somewhat crude, giving rise to the relatively wide range (60–90 percent) for the importance of environmental factors in causing cancer. Epidemiological conclusions arising from international studies, however, are supported by variations in cancer rates between natives and immigrants worldwide—immigrants generally reflect cancer incidences in their country of origin for the first generation only and succeeding generations more nearly approximate the rates of the host country.[30]

Geographical Factors

Cancer rates vary significantly throughout the United States. For whites, both male and female, there are essentially two regions—the Northeast and the Great Lakes states, which have relatively high death rates, are one; the rest of the country, with lower death rates, is the other. For male nonwhites, a belt of states with higher rates runs from Nebraska through Massachusetts; lower rates are reported throughout the southern one-third of the country. Female nonwhites have higher rates in the Northeast, Great Lakes, and Midwest and lower rates in the southern third of the country.[31] This kind of distribution is shown in Figure 8.

Figure 8

Distribution of Cancer, by Race and Sex, 1950-68


White males
Nonwhite males
White females
Nonwhite females
Observed ≫ expected
Observed > expected
Observed = expected
Observed < expected
Observed ≪ expected

Source: David L. Levin et al., *Cancer Rates and Risks*, DHEW Pub. No. (NIH) 75–691 (2d ed.; Washington, D.C.: Government Printing Office, 1974), Figure 9.

In general, states with high rates are the industrial states. Analysis county by county reveals that a majority of the areas of high mortality are located in large cities. For example, the high mortality in Illinois reflects rates in the Chicago area.[32]

Cancers of specific sites in this county-by-county mortality study also reveal geographic differences in cancer death rates (see Figure 9). For example, nonmelanoma skin cancer is seen to increase at lower latitudes, correlating with the amount of ultraviolet radiation reaching the earth from the sun.

It has long been known that densely populated and industrialized areas have higher death rates from many causes than nearby rural areas. Although urbanization and mortality have been associated for heart disease, cancer of the respiratory and digestive systems, and many other diseases, the reasons for this association are not fully understood. This excess health risk may be related to lifestyle (urban dwellers use more tobacco), to occupation (working with industrial pollutants), to the environment of cities (air and water pollution), or to other factors as yet unidentified.

Influence of National Origin

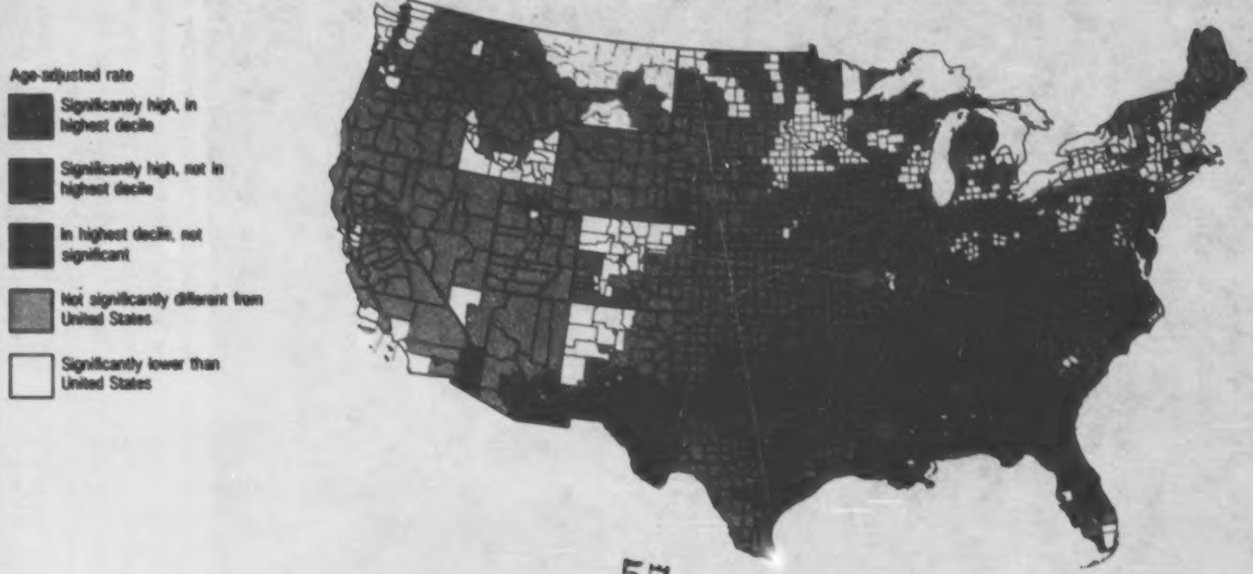
The incidence of certain types of cancer varies widely from country to country, indicating that ethnic factors may affect susceptibility to cancer. Women in the USSR, for example, have a relatively low rate of breast cancer compared to women in the United States, Canada, and England. Although stomach cancer rates have been decreasing for several decades in the United States and more recently in other industrialized countries, Japan has one of the highest stomach cancer rates in the world and shows virtually no evidence of decline.[33]

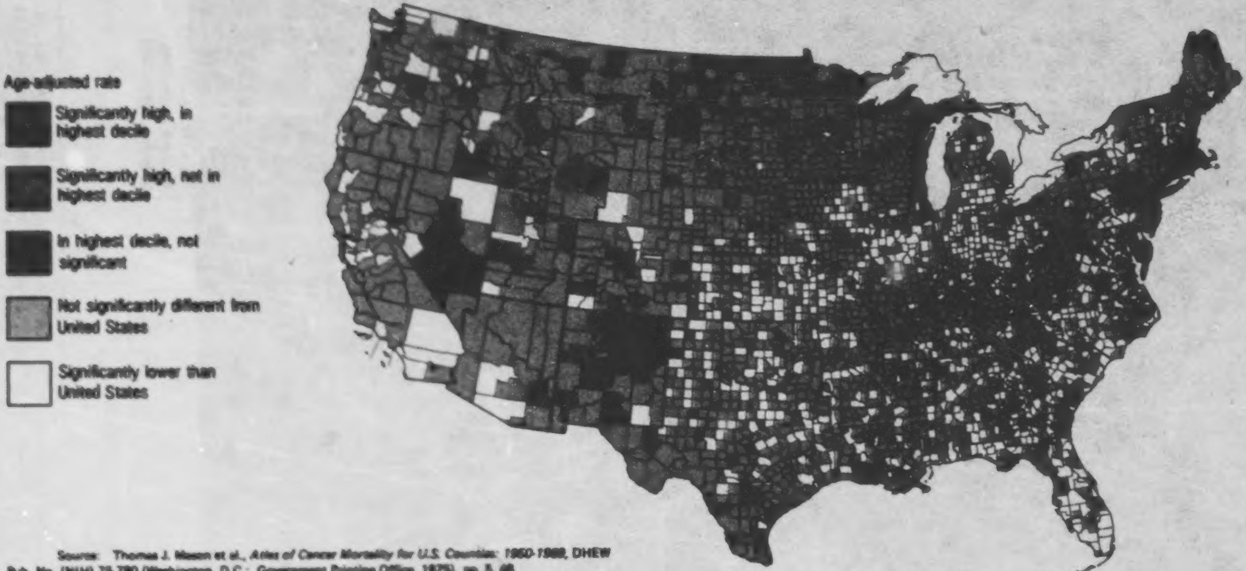
The correlation of cancer mortality and ethnic origin is reflected also in differences of mortality rates among the various foreign-born segments of the U.S. population, as shown in Table 3. For example, Mexican immigrants have a higher risk of cancer of the cervix uteri than do native-born whites; however, Finns, Swedes, and Soviet immigrants are found to have a significantly lower risk of contracting this cancer.[34]

Interpretation of these apparent differences among migrant populations is complicated by numerous factors such as variations in the quality of medical care and death certification, selective migration of persons in good or poor health, differences in socioeconomic class distribution, and urban and rural residence patterns. For example, the high mortality from cancer of the esophagus among immigrant males seems partly due to the fact that most immigrants live in urban areas where high mortality from this cancer prevails even among the native born. Nevertheless, comparisons of immigrant mortality rates with rates in their native countries strongly support the hypothesis that many cancers are largely environmental in origin.[35]

Figure 9 Cancer Mortality, Selected Sites, 1950-69

White males, nonmelanoma skin, by state economic area


Age-adjusted rate
Significantly high, in highest decile
Significantly high, not in highest decile
In highest decile, not significant
Not significantly different from United States
Significantly lower than United States


Age-adjusted rate
Significantly high, in highest decile
Significantly high, not in highest decile
In highest decile, not significant
Not significantly different from United States
Significantly lower than United States

Stomach, white females, by county

Source: Thomas J. Mason et al., *Atlas of Cancer Mortality for U.S. Counties: 1950-1969*, DHEW Pub. No. (NIH) 75-780 (Washington, D.C.: Government Printing Office, 1975), pp. 5, 48.

Table 3

Cancer Mortality of Migrants

Site	Large excess risk among migrants	Large deficit in risk among migrants
Buccal cavity and pharynx	Finland (females) Ireland Sweden (females)	Jews from several European countries including USSR
Esophagus	Austria (males) Czechoslovakia Finland (females) Hungary (males) Ireland Poland United Kingdom (females) USSR (females)	
Stomach	Austria Czechoslovakia Finland Germany (females) Ireland Japan Mexico (females) Norway Poland Sweden USSR Yugoslavia	Italy
Intestines	Ireland (males)	Mexico
Rectum	Ireland (males) USSR (males)	Mexico
Bronchus, lung, and trachea	Ireland (females) Mexico (females) Poland USSR	
Female breast		Italy Japan Mexico Poland
Cervix uteri	Mexico	Finland Sweden USSR
Bladder		Czechoslovakia (females) Italy (females) Poland (females) Sweden (females)
Leukemias and lymphomas	USSR	

Source: David L. Levin et al., *Cancer Rates and Risks*, DHEW Pub. No. (NIH) 75-691, 2d ed. (Washington, D.C.: Government Printing Office, 1974), p. 30.

Chemical Contaminants

The extent to which the observed incidence and rise in incidence of cancers are attributable to manmade chemicals cannot be estimated with any precision. Some observed cancer undoubtedly arises from natural sources like radiation and asbestos, but much of the remaining is probably associated with carcinogenic agents produced by man.

Only some of these manmade agents have been identified. A few are described below. Unfortunately, industry's capacity to develop new chemical substances far exceeds the ability of medical and scientific investigators to determine the carcinogenic potential of a chemical. In the past 10 years, the production of synthetic organic chemicals has expanded by 255 percent;[36] relatively few of the new compounds have been studied for their cancer-causing potential. Because of the typical latency period of 15–40 years for cancer, we must assume that much of the cancer from recent industrial development is not yet observable.[37]

The majority of known environmental carcinogens are encountered at the workplace.[38] In fact, the link between cancer and chemicals was first detected among workers; in 1775, soot was singled out as a causative agent in chimney sweeps' cancer, cancer of the scrotum. Above-normal incidences of cancer are found in workers having contact with known or suspected carcinogenic substances such as asbestos, arsenic, benzopyrene, benzidine, *bis*-chloromethylether, coal tar, carbon black, and vinyl chloride. Because relatively few detailed studies of worker populations have been conducted, evidence for many of these substances is only now being developed.

One such agent is benzidine, of which many million pounds are produced annually in the United States for use in making dyes.[39] An excess of bladder tumors among workers in the industry was first reported in the early 1930's. But because benzidine was just one of a number of compounds to which these workers were exposed, a specific causative agent could not be identified at that time.

Later studies of populations of workers exposed only to benzidine firmly established a cause-and-effect relationship.[40] One retrospective study of a coal tar dye plant conducted in 1965 showed that 17 of 76, 21 percent, of workmen exposed only to benzidine developed bladder tumors.[41] This incidence rate greatly exceeds that of bladder cancer in the general U.S. population—13.2 cases per 100,000 population.[42] At least 62 workers were directly involved when regulations designed to minimize exposure through work practices and controls went into effect in 1973.[43] An undetermined number of additional individuals are at risk who were previously involved in the manufacture, handling, or use of this carcinogen; given an average latency period for bladder cancer induced by benzidine and related compounds, occupationally induced cancers may be expected to develop among the exposed groups into the 1980's.

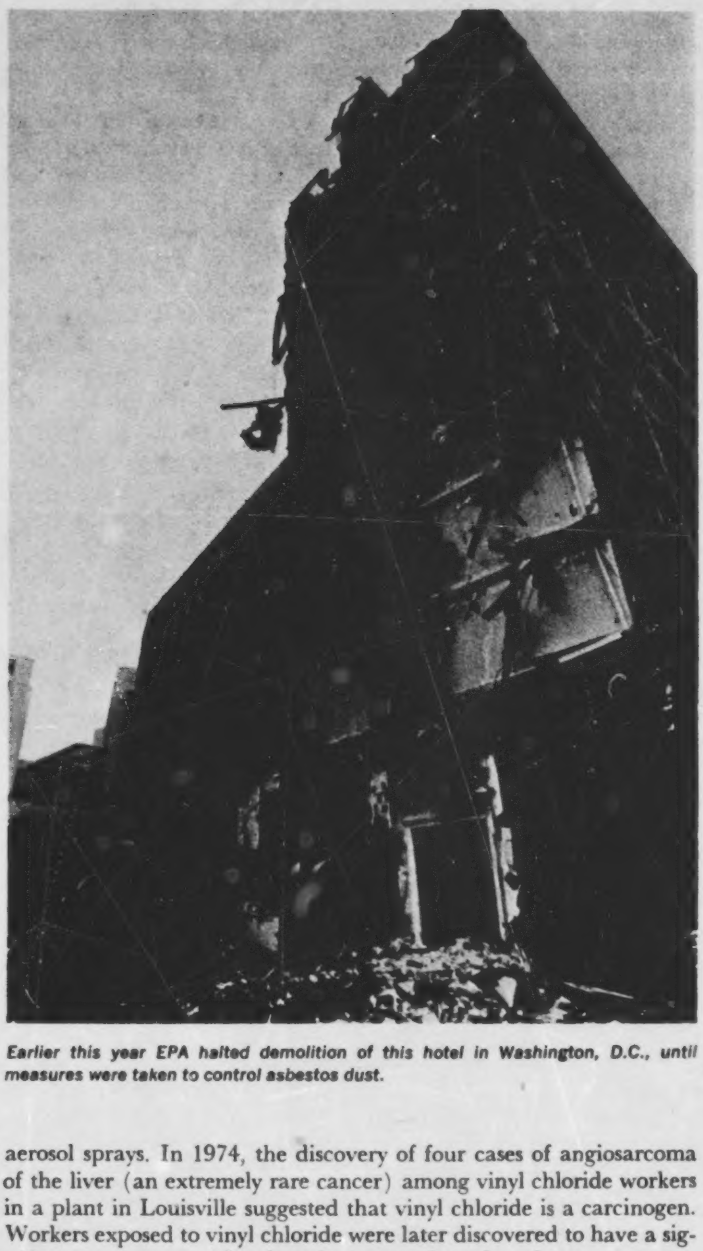
Association of occupational exposure to asbestos with increased lung cancer was first reported in the 1950's. Again, however, deter-

About 75–85 percent of lung cancer deaths are linked to cigarette smoking; lung cancer kills about 75,000 U.S. citizens each year.

mination of the causative agent was complicated by other factors like cigarette smoking.

The diagnosis of mesothelioma, an otherwise rare type of cancer, in some asbestos workers provided conclusive evidence that asbestos is a cancer hazard. Until recently mesothelioma was so rare that it is not separately coded in the International Classification of Causes of Death. Only 3 cases were reported among 31,652 cancer deaths in a 1959–62 study.[44] Yet in the past decade, mesothelioma has suddenly become more common: where environmental data exist, most victims may be traced to potential or actual asbestos exposure. This exposure often occurred in the workplace, but not infrequently it was associated only with residence in the vicinity of an asbestos processor or in the household of an asbestos worker. Asbestos products—fabrics, housing insulation, ceiling tile, brake lining—are an additional source of exposure. Identification of the link between asbestos and cancer was greatly aided by diagnosis of some excess cancers as mesotheliomas, an otherwise rare form of cancer.

Until recently, vinyl chloride, a gas used primarily in the manufacture of polyvinyl chloride plastic, was also used as a propellant for



Earlier this year EPA halted demolition of this hotel in Washington, D.C., until measures were taken to control asbestos dust.

aerosol sprays. In 1974, the discovery of four cases of angiosarcoma of the liver (an extremely rare cancer) among vinyl chloride workers in a plant in Louisville suggested that vinyl chloride is a carcinogen. Workers exposed to vinyl chloride were later discovered to have a significant excess not only of angiosarcoma but also of more common cancers of the respiratory system, brain, and the lymphatic system.[45]

Cancer hazards may be found in some consumer products. Some chlorinated hydrocarbons and arsenical pesticides that have been used in homes and gardens are known carcinogens. Commercially processed foods have also been found to contain residues of pesticides known to be carcinogenic and other chemicals suspected of being so. Foods may also contain naturally occurring carcinogens such as aflatoxins produced by particular mold contaminants. Some drugs and cosmetics have been reported as carcinogenic. These findings contributed to enactment of the Federal Food, Drug, and Cosmetic Act[46] and the Federal Environmental Pesticide Control Act.[47] Large doses of estrogen as well as synthetic drugs developed for treating common chronic conditions such as diabetes, arthritis, and anemia have been implicated in helping to produce a variety of malignant tumors.[48]

Combustion products released from industrial smokestacks as well as from chimneys of office buildings, apartment buildings, hospitals, and government and municipal buildings may contain a variety of carcinogenic materials.[49] In 1975, the Environmental Protection Agency found cancer-producing agents in low concentrations in the drinking water of all 80 cities whose water supplies it investigated.[50]

IDENTIFYING CARCINOGENS

There are currently two principal ways to identify cancer chemicals—studies of human experience and tests on animals.

HUMAN POPULATION STUDIES

Identification of chemical carcinogens through human experience requires comparing cancer incidence for selected groups of individuals exposed to known agents with incidence rates for a similar population that either has not been exposed to the same agents or has been exposed but at significantly lower levels. Such population, or epidemiological, studies have tended to focus upon occupational groups because of their relatively high exposures to substances often found in the workplace. However, air and water pollution studies may focus upon geographical areas.

Epidemiological studies are difficult to conduct because study population groups tend to be small. Seldom is it possible to isolate a single variable for study because of the complex mix of chemical agents to which humans are exposed in their work and other environments. Often exposure levels are difficult to define. Individual resistance to participation in tests and an investigator's inabilty to obtain medical histories and records may also hamper a study. And these difficulties are further complicated by the latency period between exposure and cancer symptoms.

IMPLICATIONS OF A LATENT DISEASE

It usually takes 15–40 years between exposure to a cancer-producing chemical and manifestation of the disease. However, there are documented cases of a latency period as short as 1 year and as long as 75.[51]

Age, sex, socioeconomic status, level of nutrition, and even hormone balance of an individual can hasten or delay onset of the disease. The cancer type and the nature of the specific carcinogen also affect latency. For example, the average latent period of skin cancer varies from 20 to 30 years when induced by solar radiation but is only about 7 years when caused by X-radiation. Lung cancer latency periods appear to average from 15 years to 35 years, whereas bladder cancers caused by aromatic amines range from 11 to 15 years.[52]

Exposure to other carcinogens or cocarcinogens may significantly influence latency. For example, uranium miners in the Colorado plateau are observed to have a radiation-induced cancer latency period averaging over 20 years for nonsmokers. But among those who smoke, the latency period has been only about 15 years.[53]

Generally, the greater the exposure, the shorter the latency period. In one study of bladder tumors among 78 aromatic amine workers, for instance, the length of exposure appears to correlate inversely with the length of the latency period—the greater the exposure, the shorter the latency (see Table 4). Because so many factors influence latency, however, it is impossible to define the extent to which the length and degree of exposure may be important.

Table 4

Observed Latency Period in 78 Aromatic Amine Workers

Length of latent period in years	Percentage of workers with tumors, by length of exposure in years					
	Up to 1	1	2	3	4	5 and over
Up to 5	0	0	0	0	0	0
10	0	0	0	0	0	11
15	0	17	22	0	10	45
20	4	17	22	40	30	69
25	9	17	22	70	70	88
30	9	17	48	70	80	94

Source: Wilhelm Hueper, "Medicolegal Considerations of Occupational and Nonoccupational Environmental Cancers," Ch. VII in Charles Frankel, ed., *Lawyers' Cyclopedia: and the Land* (in press).

Latency poses troublesome medical, social, and economic implications for identifying hazardous contaminants in the environment. Chemicals may appear safe for human exposure after they have been used for 10 to 15 years without obvious harm. With carcinogens, however, the lack of demonstrated damage to health even after this comparatively long period presents a false sense of security. Thirty or 40 years may be required before enough individuals have been exposed to a carcinogen at sufficient intensity to produce detectable cancers.[84] The long delay between exposure and symptoms often makes it medically and scientifically impossible to identify carcinogens in the environment.

Detection difficulties posed by the latency period are compounded by the mobility of our society. People in this country change jobs, residences, and consequently doctors and hospitals relatively frequently, so that even large-scale health effects from latent diseases may be undetected. Moreover, people are exposed to carcinogens in great variety and concentration not only on the job but in their diets and surrounding environments; this multiplicity of exposure further complicates identification of causes for any given cancer.

Some chemicals are virtually everywhere in the environment, but at low concentrations—a combination of circumstances which presents formidable problems of safety assessment for investigators. It will be extremely difficult, for example, to assess the carcinogenic impact of the pesticide aldrin/dieldrin because, as reported in Chapter 3, residues are found in 99 percent of the U.S. population. Detection of carcinogens in the environment at low levels is even more difficult when only a small percentage of the population has been exposed.

The 15- to 40-year latency period for cancer can also have extremely damaging economic impacts. By the time a health problem stemming from a chemical compound has been discovered, industry may have invested millions of dollars in plant and equipment for production. Any efforts to alleviate health risks arising from a chemical after years of such industrial activity can cause unemployment and severe disruption in the manufacturing, marketing, and distribution system. By the time vinyl chloride was discovered to be carcinogenic, industry was producing 6 billion pounds of it per year.

Even if the effects of a carcinogen can be unequivocally demonstrated as soon as those first exposed manifest symptoms of cancer (rarely the case because their first exposure occurred 15–40 years earlier) and even if exposure can be immediately eliminated (too seldom the case given economic impact and the problems of proof), society still faces several decades of cancer in individuals who have already been exposed but who have not yet manifested symptoms.

ANIMAL STUDIES

Because we have been unable to identify with sufficient precision the causes of cancer in humans already affected and because it is unacceptable to wait for additional cases of human cancer to give us the scientific evidence that we need, investigators are turning to laboratory tests on animals to study the carcinogenic potential of chemicals. Animal studies are most often conducted on small rodents such as mice, hamsters, and rats. Although as mammals rodents are biologically closer to humans than fish, birds, or invertebrates, the choice of rodents as test species is not based solely upon their similarity to man. In large part, they are chosen for scientific convenience; they are small, easy to breed, inexpensive to maintain, and have gestation periods of only a few weeks, so that an investigator can study as many as 15 generations of rodents in a single year. Most important, cancers with a latency period of 15–40 years in humans will show up in rodents in only 1 to 2 years.

There are limitations associated with use of these animals. For example, rodents are highly susceptible to laboratory infections and some species have a tendency toward fighting and cannibalism.

Animal studies typically use either a heterogeneous group of animals—one exhibiting a wide variety of physical and physiological traits, as humans do—or a carefully inbred strain that continues to exhibit the same well-defined characteristics generation after generation. Inbred strains offer experimental advantages and disadvantages; in studies of the carcinogenic potential of ultraviolet radiation on the skin, for example, hairless strains eliminate the need for removing the test animal's hair so that radiation can reach the skin. On the other hand, an inbred strain may have either an abnormal sensitivity or resistance to the carcinogenic effects of a chemical.

Study groups usually consist of 20–100 test animals as well as a similar number of control animals. The controls are stored, fed, handled, and analyzed in precisely the same fashion as the test animals except that they are not exposed to the chemical under investigation. Both groups are allowed to live until spontaneous death (about 3 years for rodents) or are sacrificed and examined before then.

The chemical being tested may be administered to the animal in any one of several ways, by ingestion through food or water, inhalation, injection under the skin or through the skin into the stomach, application to the skin, or directly to the stomach by means of a throat tube. Ingestion, inhalation, and skin application correlate with the normal modes of human exposure. Injection and a tube to the stomach are the favored methods when the amount of exposure must be measured precisely.

Levels of Exposure

Although it is sometimes argued that any chemical fed animals in large enough quantities will be carcinogenic—even such chemicals as table salt and sugar—there is little evidence to support this contention.[55] There is, however, a direct dose-response curve for carcinogens. The higher the exposure of a subject (irrespective of exposure duration), the greater the likelihood that the disease will be contracted by either animal or man. Conversely, the lower the dose, the smaller the probability.

The level of chemical exposure in animal tests is usually much higher than that found in the environment. This fact has been used to discredit animal test results. The relatively high dosage used in chemical screening experiments, however, is intentional.

In the laboratory, if a chemical is administered at a dosage that poses only a 1–2 percent risk of inducing cancer, it is quite possible that there would be no sign whatsoever of cancer in any of 50 test animals. With such a small population, a relatively large effect must occur for it to be observable and statistically confirmed. A 1–2 percent risk of cancer is unacceptable for human exposure—in the United States it would correspond statistically to 1–2 million cases of cancer. Because of the constraints on the number of animals that may be used in a study, therefore, the investigator must increase the dosage to produce an effect or, alternatively, to confirm that there are no important effects.

The administration of chemicals in high doses has one possible shortcoming as a testing technique. It may cause other toxic effects that kill animals before cancer symptoms become manifest. For this reason, prior to long-term studies, most toxicologists feed varied dosages of a test chemical to a small group of animals in order to determine the level at which serious toxic effects show up. On the basis of this information, investigators can choose an experimental dosage level well below the acute toxic level.

Validity of Animal Studies

Much is unknown about the biology, metabolism, and biochemistry of both man and rodent test species. Furthermore, the detailed biochemical mechanisms by which cancers develop are not understood. However, the genetic materials DNA and RNA are found in every living cell. Although these complex chemicals vary from species to species and from individual to individual, the basic chemical building blocks which make up DNA and RNA are believed the same for man and other animals. According to one widely held theory, it is the reactions with DNA and RNA that cause a chemical to be carcinogenic; if this theory is correct, then these chemicals may behave similarly throughout the animal kingdom with respect to carcinogenicity.

The validity of applying animal test results to man is firmly based upon empirical evidence. Not only have rodent experiments given positive carcinogenic test results for compounds known to cause cancer in man, but also—in every case except arsenic—each chemical known to cause cancer in man has been found to do so in animal species. Although there may be wide variations in the susceptibility of various species to cancer, evidence indicates that a chemical that causes cancer in one animal species is likely to do so in most other

Animal tests are expensive, but they are currently the only proven method for screening compounds for cancer-causing properties. Here a rat is weighed before being injected with a suspect compound, and a tissue sample of an organ is prepared for examination for cellular changes.

species tested. The preponderance of scientific data indicates, in sum, that rodents are suitable test models for determining the cancer-causing potential of a chemical.

Unfortunately, animal models are less useful in assessing the degree of risk that a cancer-causing chemical poses. Although animal tests may indicate that some chemicals are more carcinogenic than others, direct quantitative extrapolation from animals to man is not possible. Varying metabolic rates and other biological differences contribute to this uncertainty. Thus, even if animal studies indicate that a given chemical poses a cancer risk, the magnitude of the risk will remain uncertain.

EMPIRICAL RESULTS

Although it is difficult to estimate, between 10 and 16 percent of the chemicals tested for carcinogenicity produces cancer in animals.[98] Of some 2 million known chemicals, however, only about 6,000 have been laboratory tested for carcinogenicity.

One can speculate that the chance any given chemical in the environment will be carcinogenic is probably well below 10 percent because of the way in which chemicals are chosen for testing or are reported as being carcinogenic.

- Not every compound reported positive for carcinogenesis has been tested under proper experimental conditions. For example, positive results may stem from carcinogenic impurities in an otherwise noncarcinogenic chemical.
- Most chemicals screened for carcinogenicity are compounds such as pesticides or pharmaceuticals. By definition, such compounds are extremely active biologically (i.e., alter biological functions) and would thus be more likely to induce cancer.
- Many compounds are selected for testing because their chemical structure or biological activity resembles that of known carcinogens. Thus testing tends to be restricted to compounds most likely to be found carcinogenic.
- Many compounds have probably been tested and found to be noncarcinogenic, but the test results have not been published.

Empirical observations indicate that many carcinogens fall into certain chemical classes. If the chemical structure of a chemical resembles that of a compound known to be carcinogenic, there is a likelihood that both are carcinogenic. However, the converse is not necessarily true; the fact that a chemical is not similar in structure to any known carcinogen does not prove that it is safe. A list of some carcinogenic groups and their common uses is given in Table 5.

Because of varying reactivity and structural factors, chemicals vary widely in their cancer-producing capabilities. Some carcinogens, such as *bis*-chloromethylether, are potentially carcinogenic even at a concentration of a few parts per billion. Other closely related chemicals

Table 5

Chemical Classes of Carcinogens

Classes/examples	Sources of exposure
Aromatic amines	
β-napthylamine	Manufacture of rubber products
Benzidene	Dyemaking
Nitrosamines	Rubber additives, present in or metabolized from nitrosamine or nitrites in foods, present in tobacco smoke
Chlorinated hydrocarbons	
Vinyl chloride	Intermediate in PVC plastics manufacture
Aldrin/dieldrin	Pesticide
DDT	Pesticide
bis-chloromethylether	Impurity in certain chemical resins
Polynuclear aromatics (tars)	
Anthracene	Tobacco smoke
Benzo(a)pyrene	Polluted air from combustion of fossil fuels
Radioactive elements	Various medical, scientific, and other uses
Metal dusts	
Beryllium	Lightweight alloys, component of rocket fuel
Chromates	Paint pigments
Arsenic	Pesticides, pharmaceuticals
Steroid hormones	
Diethyl stilbesterol (DES)	Animal feed additive, "morning after" pill

are much weaker carcinogens; *bis*-chloroethylether appears to be a much weaker carcinogen, and any resulting cancers are much more difficult to detect.

It is estimated that between 60 and 90 percent of all cancers are related to environmental factors. Yet of the multitude of agents in the environment, probably only a small fraction—perhaps less than 1 percent—is responsible for this large effect.

Survival rates have improved significantly only for a few cancers in the last 30 years. Improvement has been the result of advances in cancer therapy and an emphasis on early detection. Generally progress has been slow and some cancer types defy all forms of treatment. A major effort has been launched to do better. But cancer incidence and mortality would probably be reduced at a better rate by the elimination of its causes—a preventive effort that has only just begun.

Most carcinogenic compounds known today fall into a few categories of chemical structure. Theoretically it is possible to predict that other chemicals falling into these categories will also be carcinogenic; unfortunately, we simply do not know enough to predict with confidence that a compound will not be carcinogenic if it falls outside these structural categories. Testing, therefore, is necessary to confirm the noncarcinogenicity of a compound.

Of those chemicals known to be carcinogenic only a fraction are so in the form in which they exist in the environment. Some compounds, therefore, are directly carcinogenic and are likely to cause cancer in whichever tissues they reach. In other cases, noncarcinogenic chemicals can be altered by metabolic processes to form a carcinogenically active chemical. For example, benzidine is not believed to be carcinogenic until metabolized to an active form in the liver. Subsequently, it is concentrated in the bladder, the principal organ that it attacks.[57]

Some carcinogens, such as vinyl chloride, induce malignancies at multiple locations in the body while others, such as benzidine, are tissue- or organ-specific. Site-specific carcinogens tend to be chemicals that are metabolically converted to an active form in or near the organ that they affect.

COCARCINOGENS

Whether found in polluted urban air, in cigarette smoke, or in some products derived from coal tar and petroleum, environmental carcinogens usually occur in a complex mixture. The mixture of chemicals can multiply the risk of cancer that would be encountered with one carcinogen alone. For example, although 75–85 percent of lung cancers are related to smoking, particularly cigarettes, atmospheric pollution and some occupational exposures appear to exacerbate the risk. According to one calculation, asbestos workers who are nonsmokers contract lung cancer at normal rates, but a cigarette smoker who works with asbestos has eight times the risk of dying of lung cancer as similar smokers of the same age who do not work with asbestos and 92 times the risk of laborers who neither work with asbestos nor smoke.[58]

Asbestos seems to be a cocarcinogen with cigarette smoke in lung cancer. Other cocarcinogens that by themselves may not cause cancer may do so in the presence of other chemicals. Cocarcinogens, therefore, may be nearly as important as known carcinogens in multiplying the cancer risk posed by chemicals.

APPROACHES TO CANCER CONTROL

There are basically two approaches to cancer control—prevention and treatment. Most of the effort has been directed toward cancer treatment or cure. The effectiveness of this approach to date may be measured by survival rates and trends.

SURVIVAL RATES AND TRENDS

The most important determinants of cancer survival are the type of cancer and the degree to which the malignant tumor has spread when treatment begins. Other factors include the age, sex, race, and general health of the patient and the method of treatment. Patients with cancer of the corpus uteri, cervix uteri, and breast have the highest relative survival rates and the longest median survival times,

Average hospital costs for cancer range from $1,000 to $3,000; with physician and outpatient costs added, the total cost for medical care for a particular patient may range from $5,000 to over $20,000.

whereas patients with cancer of the pancreas, lung, and bronchus and acute leukemia have the lowest survival rates.[59]

Generally speaking, the outlook for survival decreases with age. However, for children 15 years of age and under, the chance of survival is as low as for patients 65 years of age or older.

The greatest improvement in survival rates for most types of cancer occurred between the 1940's and 1950's probably because of advances in detection, treatment, and surgical technique (see Table 6). Although continued progress has been registered for several types of cancer since the 1950's, 3-year survival rates for others stubbornly resist change. The current survival rate for stomach cancer, for example, remains at its 1950's level, and the rate of cancer of the pancreas has not budged since the 1940's. The survival rate for lung

Table 6

Three-Year Cancer Survival, by Site, 1940–69

Site	1940–49		1950–59		1965–69	
	Number of cases	3-year survival (percent)	Number of cases	3-year survival (percent)	Number of cases	3-year survival (percent)
Stomach	7,390	12	9,987	15	3,889	15
Colon	7,488	36	16,153	49	10,152	50
Rectum	6,979	35	10,901	47	5,512	49
Pancreas	2,009	2	4,391	2	2,888	2
Larynx	1,462	47	3,259	60	2,725	67
Lung and bronchus	4,772	6	16,072	10	15,941	11
Female breast	12,184	63	22,105	71	14,911	72
Cervix uteri	7,075	53	10,280	64	4,888	63
Corpus uteri	3,509	66	5,529	74	4,400	76
Ovary	2,339	30	4,296	33	3,085	35
Prostate	6,008	49	11,647	59	7,384	66
Bladder	4,337	48	8,350	58	5,295	62
Melanoma of skin	749	49	1,982	63	1,996	74
Brain and cranial meninges	2,437	28	4,679	28	3,810	37
Thyroid	697	67	2,377	81	1,445	86
Hodgkin's disease	1,013	35	2,008	44	1,990	61
Multiple myeloma	391	10	1,328	13	1,116	27
Acute leukemia	922	4	2,837	14	2,432	30
Chronic leukemia	1,599	24	3,627	35	1,587	41

Source: David L. Levin et al., *Cancer Rates and Risks*, DHEW Pub. No. (NIH) 75–691 2d ed. (Washington, D.C.: Government Printing Office, 1974), p. 30.

cancer—the most common form among males—rose from 6 percent in the 1940's to 10 percent in the 1950's but improved only slightly, to 11 percent, during the next decade. Thus survival rates have improved only modestly—especially in recent years.

CANCER PREVENTION

Compared with the amounts of human and financial resources invested in therapy, the investment in cancer prevention has been small. Basic research, animal studies, and human population studies aimed at carcinogens before their introduction into the environment are being conducted by the Environmental Protection Agency, Energy Research and Development Administration, and many of the component agencies of the Department of Health, Education, and Welfare, including the Center for Disease Control, National Cancer Institute, National Institute of Environmental Health Safety, National Institute of Occupational Safety and Health, and National Center for Toxicological Research, which is jointly sponsored by the Food and Drug Administration and Environmental Protection Agency. To a lesser degree, the Department of Defense and Consumer Product Safety Commission have similar programs. Chemical testing of potential food additives and drugs is required of manufacturers under the

Federal Food, Drug, and Cosmetic Act administered by the FDA.[60] Similarly, testing of pesticides is provided for by the Federal Environmental Pesticide Control Act administered by EPA.[61] With minor exceptions there are no authorities to provide for the testing of any other commercially introduced chemicals.

Given the modest advances in cancer therapy and the attendant suffering even on the part of those cured of the disease, an increased cancer prevention effort would seem warranted to supplement our attempt to find cures. This effort should involve basic research, human population studies, animal tests, and the elimination or reduction of unwarranted carcinogenic exposures.

Because it is clearly unacceptable to rely upon human studies for carcinogen identification, a preventive approach to cancer should emphasize animal testing and the elimination or reduction of unwarranted carcinogenic exposures. (See Chapter 2 for a discussion of toxic substances control legislation pending in the Congress as of mid-1975.)

The financial, physical, and human constraints upon animal tests help explain why only a small proportion of the chemicals used today have been studied for carcinogenicity. Yet the need for tests increases with the constant development of new chemicals.

FUTURE TESTING

Costs and time delays may be substantially reduced if one or more new test systems, currently under investigation, prove as useful as early findings suggest. These new systems are generally *in vitro* methods (outside the body, e.g., in test tubes), as opposed to *in vivo* methods (in the living organisms). Most involve cultures of living cells, often bacterial but sometimes human, to which the test chemical is added. The cells are then monitored.

ERDA, EPA, and HEW are sponsoring research at several universities and in their own laboratories in an effort to develop these tests as rapidly as possible. If the tests prove to be valid models, they offer the hope of reducing the 2- to 3-year testing time for carcinogenicity to as little as 1 week, of reducing the costs from many tens of thousands of dollars to perhaps less than $1,000 per compound, and thereby of greatly increasing the number of chemicals that may be screened before commercial production introduces them into the environment.

SUMMARY

Over the past 100 years there has been a significant rise in life expectancy, particularly in the developed portions of the world. It is the result of reduced infant mortality, advances in medical technology and health care delivery, and the virtual elimination of infectious disease as a major cause of death. But since 1950, there have been no

Screening substances for carcinogenic effects may become substantially faster and cheaper with techniques now under investigation that use cultures of bacterial or human cells.

appreciable changes in life expectancy in the United States. The two leading causes of death in the United States, heart disease and cancer, have increased since 1900 at a rate much higher than may be accounted for by population growth and by aging of the population. Environmental influences may already be factors in life expectancy and health in the United States.

Cancer, the focus of this chapter, has more than doubled since the turn of the century. Much of the increase may be attributed to cigarette smoking, but overall cancer rates exclusive of lung cancers are also rising.

Cancer has a long latency period. In humans there is usually a 15- to 40-year lag between cause and effects. There is no indication that long-term exposure to carcinogens is necessary to produce cancer. Although increased levels of exposure to a carcinogen carry with them an increased risk of developing cancer, a single exposure to a chemical may also result in a cancer.

The delayed symptoms and the mobility of society—geographically, occupationally, and economically—make detection of the causes of human cancers very difficult. Many chemicals demonstrated to have affected humans are known only because previously rare forms of the disease were manifested in select groups of people, typically workers. Thus, the latency period can provide a false assurance of safety for carcinogenic substances.

With only modest recent improvements in cancer therapy, the only prudent policy toward cancer is to increase the emphasis on prevention. Prevention entails identification of cancer risks prior to human exposure. Scientist policymakers are relying on laboratory experiments, principally upon anmials, to evaluate the cancer risk and to develop public health policies. A detailed metabolic link between man and rodents (the most commonly used laboratory animals) is not firmly enough established to justify good quantitative dose-effect correlations between animal study results and anticipated human experience. Yet animal tests have empirically proven quite predictive qualitatively of carcinogens in humans. Thus animal tests are useful tools prior to significant human exposures to carcinogenic or suspected carcinogenic chemicals which may pose an unknown cancer risk.

The tests are expensive and time-consuming. Screening methods currently under development, involving human or bacterical cells grown in laboratory test tubes or petri dishes, offer the hope that rapid, inexpensive indicators of the cancer-causing potential of chemicals may soon be available.

Development and use of such screening methods are the potential foundation for a national cancer policy that would prevent this menacing disease rather than attempt to treat it after it has struck.

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CHAPTER 2

PERSPECTIVES ON THE ENVIRONMENT

This chapter provides background on environmental issues and looks at events of the past year that had an important impact on them. Several of these noteworthy events were court rulings—applications of existing law to new environmental questions. Others represented efforts to adjust environmental regulations to economic stresses. Despite continuing hard questioning of environmental improvement efforts, spokesmen for both industry and government have begun to show less and less inclination to dismiss environmental concern as a faddist nuisance. Consideration of environmental factors is becoming more accepted as a valid component of private and public decision-making.

By mid-1975, the economy seemed to be headed for a slow but sustained recovery; nevertheless, the threat of recession shaped much of the debate over efforts to improve environmental quality in the 12 months preceding, and the memory of that threat will undoubtedly furnish the backdrop for such debate in the next few years.

The chapter is divided into four parts: Pollution, Energy, Land and Water Resources, and Public Lands. In turn, each is divided into sections dealing with specific subjects, such as air and water under Pollution, and grazing and timber under Public Lands. A background statement, a discussion of events of the past year, and a brief identification of issues to watch for is presented under each topic.

A number of subjects are being included in the chapter for the first time this year. The section on land use, which was a separate chapter in last year's report, covers a number of transportation and agriculture issues not reviewed previously. The sections on the coastal zone, water resources, outdoor recreation, grazing, timber, and mining are considerably expanded from their treatment in past reports. With these changes, we are attempting to make the chapter a more comprehensive view of current and emerging environmental issues.

POLLUTION

Pollution in its various forms—air, water, noise, solid waste, and hazardous substances—has been an environmental concern for many years. In general we all agree that pollution should be reduced. Differences arise over how serious a problem one particular type of pollution may be, whether the technology to abate it is available, and whether the degree of abatement achieved is worth the costs.

The Environmental Protection Agency is the federal government's pollution regulation agency. And air, water, and noise pollution are the subjects of comprehensive federal laws. The Clean Air Act Amendments of 1970 provide a cooperative federal-state framework for air pollution abatement based on the regulation of both stationary sources (such as powerplants) and mobile sources (chiefly the automobile) to meet ambient air quality standards. The Federal Water Pollution Control Act Amendments of 1972 progressively tighten the commitment to clean water by mandating dischargers to use best practicable and then best available technologies by specific dates. The FWPCA also provides massive federal assistance to states and municipalities to meet the cost of improving sewage treatment. The Noise Control Act of 1972 establishes authority for EPA to issue standards for identified categories of vehicles and products. Hazardous substances are regulated in part by a number of federal statutes. Comprehensive regulatory authority to control such pollution is still under consideration by the Congress, although pesticides are regulated by EPA under the 1972 Federal Environmental Pesticide Control Act. Solid waste is not subject to federal regulatory authority, but a growing number of states are enacting regulatory and coordinative legislation. Radiation, regulated by both EPA and the Nuclear Regulatory Commission, is discussed in the section on energy later in this chapter.

The controversy over air pollution and energy requirements and the debate over emission controls on automobiles have received considerable attention from the executive branch, the Congress, and the public in the past year. In addition, the Congress has been debating amendments to the Clean Air Act, which was last significantly revised in 1970. Next year the debate will likely shift to water pollution, and its focus will be the recommendations of the National Commission on Water Quality on how to improve the nation's approach to solving the complex and costly problems of water pollution.

The commission report to the Congress, due late in 1975 in preliminary form, will serve to kick off what promises to be a major reevaluation of water quality programs.

The sections which follow discuss these air and water quality issues as well as aspects of pollution from noise, solid waste, and hazardous pollutants.

AIR

Serious concern about air pollution in U.S. cities dates from the end of World War II. Although over the years we have made much progress, the effort to clean up our air still faces knotty technological and economic problems. This section describes the major regulatory, judicial, and legislative developments of the past year and focuses on unresolved issues in the debate over how best to achieve our clean air goals.

BACKGROUND

The first attack on air pollution was mounted by the states as one by one they enacted laws governing their jurisdictions. The Congress followed with a series of laws intended to provide a framework for cleaning up the air throughout the nation in a concerted, comprehensive fashion. The most important of these federal laws were the Clean Air Act of 1967 and the Clean Air Act Amendments of 1970.[1]

The 1967 act embodied the concept that air cleanup required a national effort, but it specified that the states should retain primary authority and responsibility for doing so. The 1970 amendments provided for development and enforcement of two kinds of standards for ambient air quality—"primary" standards necessary to protect health and "secondary" standards desirable to protect welfare, including property and aesthetics. The amendments' stated goal was achievement of primary standards throughout the nation between 1975 and 1977.

The amendments also set forth a two-part strategy for attaining this goal. First, the federal Environmental Protection Agency was to establish air quality standards for six major classes of pollutants: particulates, sulfur oxides (SO_2), hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), and photochemical oxidants. EPA promulgated standards for each class in November 1971.[2]

Next, the states were to develop state implementation plans, indicating how they intended to achieve the EPA standards. Each implementation plan, typically, is a compilation of state air pollution statutes and regulations and of pollution control strategies—including emission limitations, land use controls, and transportation controls. EPA is required either to approve the state implementation plans, thus making them part of federal law, or to amend them in conformance with EPA criteria for attaining ambient air standards.

Because different geographical, climatic, and other conditions introduce necessary variations in the state plans and because each plan contains several often complex programs, EPA developed a policy of approving them on a program-by-program basis. The resulting constant review process has given EPA and the states the flexibility required to revise plans in accordance with later changes ordered by the courts or the Congress. To date, no state implementation plan has been approved in its entirety by EPA.

The Clean Air Amendments of 1970 were intended to minimize emissions of pollutants from new sources. EPA established emission standards for major new "stationary" sources, such as powerplants, factories, and refineries, and for new "mobile" sources, such as automobiles and trucks that had not yet come off the production line. For example, the Clean Air Amendments required a 90 percent reduction in major pollutants from automobiles within 5 years.[3]

EVENTS OF THE PAST YEAR

Overall Compliance

The Clean Air Amendments of 1970 set mid-1975 as the first major deadline for attainment of primary air quality standards nationwide. On May 30, 1975, EPA Administrator Russell Train presented the results of the agency's latest assessment of compliance, complete through December 1974.[4] It showed that SO_2 had been reduced 25 percent nationwide. This decrease in SO_2 concentration is particularly evident in major metropolitan areas. Particulates, the other main pollutant from stationary sources, had been cut by 14 percent. Of the approximately 20,000 major stationary sources, 15,600 had either met the standards or had a schedule for doing so.

With respect to mobile sources, emissions from 1975 model automobiles had been reduced 67 percent from emission levels in vehicles built 5 years before. This compared to a 90 percent reduction mandated by the Clean Air Amendments, but the earlier goal had been modified by the Congress in the Energy Supply and Environmental Coordination Act of 1974.[5] Further, the assessment showed that compared to uncontrolled emissions, automobile emissions had been reduced: HC and CO levels were each 83 percent lower, NO_x levels were 13 percent lower.

Despite these reductions, of a total of 247 air quality control regions, 153 are expected not to meet the standards—59 on SO_2, 79 on photochemical oxidants, 69 on CO, and 16 on NO_x. Trends in reducing emissions and ambient pollution levels are discussed further in Chapter 3.

Validity of the six ambient air quality standards established by EPA in 1971 continues to be supported by technical studies. In September

Smog envelopes the famous Gateway Arch in downtown St. Louis.

1974, the National Academy of Sciences published its final report to the Senate Public Works Committee on the question of whether the standards should be changed.[6] It concluded that "in general . . . the evidence that has accumulated since the promulgation of the Federal ambient air quality standards by the EPA Administrator on April 30, 1971, supports those standards. . . . On balance, the panels [studying the evidence] found no substantial basis for changing the standards."

Stationary Sources

The past year presents a mixed picture on air pollution from stationary sources, with progress on some issues but little more than continued debate on others. Final regulations on the "significant deterioration" issue were promulgated, but litigation and Congressional review have prevented their implementation. Better progress was made on the "scrubber" issue through agreement among federal agencies on a long-term strategy. The economic impact of air quality compliance efforts and the possibility of plant closings was highlighted by an enforcement action against U.S. Steel in Gary, Indiana. And the effort to accommodate air quality to energy conservation and development goals continued to generate controversy and legislative proposals.

The Scrubber Controversy Early attempts to control SO_2 emissions from electric generating plants relied on use of low sulfur coal, oil, or natural gas rather than on equipment to remove pollution after combustion of dirty fuels. It soon became clear that supplies of low sulfur fuel were insufficient to permit attainment of national ambient air quality standards by 1975. This dilemma was accentuated by the Arab oil embargo, which made it evident that the United States would have to expand its use of coal, including at least some higher sulfur content coal.

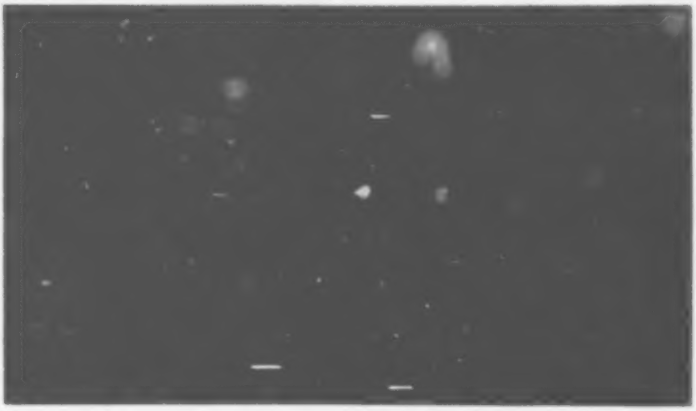
A major controversy evolved over the advantages of flue gas desulfurization devices (scrubbers) versus those of intermittent control systems for controlling SO$_x$ emissions from high or medium sulfur fuels. Scrubbers remove sulfur from stack gases after combustion but before emission to the atmosphere. Intermittent control systems seek to disperse stack gas and dilute SO$_x$ emissions by use of tall stacks and various operating practices, including curtailing operations or switching to low sulfur fuels during times of adverse air quality or other unusual meteorological conditions.

Scrubbers have been vigorously opposed by elements of the utility industry as well as by some federal agencies on the grounds of high cost, lack of technical reliability, and disposal problems of the sludge byproduct. Opponents argue that intermittent controls could meet ambient standards.

Proponents argued that permanent controls on SO$_x$ emissions were required under the Clean Air Act to protect public health and facilitate enforcement and that scrubbers are a demonstrated and economically feasible control technology. The U.S. Court of Appeals for the Fifth Circuit lent support to the argument for scrubbers in *Natural Resources Defense Council* v. *EPA*,[7] a 1974 opinion. There, the court held that intermittent control systems are acceptable only when emission reduction equipment is unavailable.[8]

The debate resulted in a November 1974 decision by the Administration to permit use of intermittent controls by some isolated existing rural powerplants up to but not later than 1985, but in the meantime they must meet ambient air quality standards through intermittent control systems. Powerplants are required to sign a compliance schedule for installing permanent controls consistent with the availability of scrubbers and with the reliability of power generation. Amendments to the Clean Air Act necessary to implement this decision were proposed by the Administration in January 1975.[9]

Variances The Clean Air Amendments provide for attainment of ambient air standards by 1975 (or 1977 if a 2-year extension has been granted). Most state implementation plans were drafted so that all emission limitations were effective immediately. Because most sources were not in compliance with emission limitations of implementation plans, there was a transition period (still continuing for some) between the time a plan became effective and the time that ambient air standards had to be attained. The most common way of dealing with source noncompliance was for a state pollution control authority to issue a variance from the requirements, provided that the source and the state reached a mutually acceptable com-



The mineral processing facilities of Kennecott Copper Corporation's Utah Copper Division have been granted a variance beyond the attainment date for SO_2 and particulates by the Utah Air Conservation Committee.

pliance schedule and that the national ambient air quality standards were met by the statutory deadlines.[10] EPA took the position that such variances would be treated as revisions of the state implementation plans, requiring only approval by EPA.

This variance procedure was challenged throughout the country. Opponents argued that once a plan was approved, an individual source could be excused from full compliance with all emission limitations only by obtaining an extension under section 110(f) of the Clean Air Amendments. Section 110(f) permits an extension of no more than 1 year upon application from a state Governor to EPA if four conditions are met—good faith efforts must have been made to comply with the implementation plan, failure to comply must result from lack of available technology, all available controls including interim controls must be installed, and continued operation of the source must be essential to national security, the public health, or welfare. Adjudicatory hearings are also required under section 110(f).

The controversy over which procedure should be used—the easier, state-granted variance or the tougher, lengthier extension under section 110(f)—soon resulted in several suits before different courts of appeals. The first three courts to rule decided that states were free to issue their own variances until the 1975 or 1977 deadlines for ambient air standards and that such variances could be approved as implementation plan revisions. After those deadlines, only the section 110(f) procedure would be permitted regardless of whether the variance would cause the ambient standards to be exceeded.[11] EPA changed its regulations to adopt the holdings of these courts.

But then the Court of Appeals for the Fifth Circuit, in a 1974 opinion, agreed with plaintiffs, who opposed the state variance procedure. The court ruled that the strict provisions of section 110(f) should govern all extensions, even if a state-granted variance expired before the deadline and even if the variance did not jeopardize attainment of ambient air standards.[12]

Upon petition by EPA, the Supreme Court then issued a writ of certiorari—essentially a notice of intent to analyze the rulings of the lower courts and to adjudicate which procedure should be used. Before the various parties to the controversy could present their arguments to the Supreme Court, the Court of Appeals for the Ninth Circuit ruled that variances were permissible at any time, as long as ambient air standards were not violated.[13] Shortly after, in April 1975, the Supreme Court adopted this position.[14]

The Court held that the purposes and philosophy of the Clean Air Act of 1967 were not changed by the 1970 amendments. Accordingly, the chief responsibility for attainment of ambient air standards rests with the states. So long as a state's control strategy achieves and maintains ambient air standards, the Court ruled, EPA cannot interfere with the state's timing or its enforcement techniques.[15]

Clean Air and the Economy As reported in Chapter 4 on economics, studies by EPA have consistently shown that pollution abatement costs can be borne by industry without an appreciable increase in plant closures.[16] However, as the economic situation became more serious throughout 1974 and as fuel costs rose sharply, the potential for conflict between jobs and clean air increased. The issue surfaced on December 27, when the U.S. Steel Corporation announced that it would close down the last of its 53 open hearth furnaces in Gary, Indiana, rather than pay a daily fine for violating a consent decree entered into with EPA under court supervision.

In 1965, U.S. Steel had agreed to close the 53 furnaces by December 31, 1973, and to replace them with newer, less-polluting equipment.[17] After obtaining two 6-month extensions, U.S. Steel returned to court with a request for another 90-day extension. The U.S. District Court judge refused the request and gave U.S. Steel the choice of closing the remaining units or paying a daily fine of $2,300 until they were phased out. U.S. Steel opted to close the furnaces, estimating that the closings would idle 2,500 workers in Gary and several thousand more in related industries.

U.S. Steel subsequently invited EPA to join in a petition, asking the judge to grant a further extension to June 30 for final phaseout of the open hearth furnaces. This would permit U.S. Steel to reopen the facilities, and the corporation would post a $200,000 performance bond to guarantee phaseout by June 30.

EPA officials rejected the proposal on grounds that its acceptance would condone a violation of the earlier consent decree with no penalty assessed against the corporation, encouraging other polluters to close—or threaten to close—pollution-emitting facilities in order to obtain concessions. Further, EPA pointed out, the daily penalty would have amounted to less than $1 per worker, if 2,500 were laid

Following an enforcement action in 1973, this steel plant in Gary made a beginning in achieving significant reductions of emissions in compliance with the Clean Air Act.

off. In the end, U.S. Steel furloughed only 500 men for 60 days and rehired 350 of them before the 60 days had passed. The corporation ultimately laid off about 150 workers, mostly through early retirement.[18]

Coal Conversion The Energy Supply and Environmental Coordination Act of 1974 encourages a shift from oil or gas to coal in fossil fuel powerplants. The act amended the Clean Air Act by authorizing a delay until 1979 for achievement of standards by any powerplant or industrial boiler converting to coal as a result of an order from the Federal Energy Administration. The authority was limited by a number of explicit conditions.[19]

To give EPA more flexibility in extending air quality deadlines for facilities converting to coal, in early 1975 the Administration proposed a number of further amendments to the Clean Air Act.[20] The major new authority would allow delays to 1985 for compliance by such facilities.

Significant Deterioration On May 30, 1972, the District of Columbia District Court ruled that according to the provisions of the Clean Air Act, no state could permit "significant deterioration" of air quality in areas where it was already cleaner than required by ambient standards.[21] This ruling was upheld by the Supreme Court,[22] and on August 16, 1974, EPA proposed regulations to incorporate the District Court opinion into state implementation plans.

The EPA regulations, covering particulates and SO_2, were published after long public debate about the nature and severity of the controls. Those seeking strong controls had argued that the court

The Four Corners Power Plant in northwestern New Mexico operates in an otherwise pristine area. Similar facilities in the West will be subject to significant deterioration regulations.

ruling required state implementation plans that would fully protect clean air areas from pollution by new industrial facilities. Those favoring less control argued that there must be some provision for growth and industrialization even in clean air areas and that a strict interpretation of "significant deterioration" by EPA would in effect amount to land use controls prohibiting new industrial development.

The proposed final regulations separate areas into three classifications—Class I, where air quality would be protected at existing levels, Class II, where moderate changes would be permitted, and Class III, where major industrialization and growth would be allowed to a point at which air pollution reaches national standards. All areas were to be established as Class II areas at first, with authority given state Governors to change any to Class I or III. In this way, the federal government would not be forced to determine industrial siting policies for regions based on air quality alone but would allow wide discretion to the states. The regulations were adopted in final form by EPA on November 27, 1974.

The regulations have been challenged from both sides. Industrial groups have sought to have the regulations set aside as an arbitrary and capricious exercise of authority. At the same time, the Sierra Club (the successful plaintiff in the original district court suit that forced promulgation of the regulations) and other environmental groups brought legal challenges on two grounds—that the regulations allowing growth and siting of facilities in Class III areas violate the court order and that the act does not allow limiting the regulation to particulates and SO_x emissions but requires that at least HC and NO_x be included. Although the regulations were to take effect July 1, 1975, these court challenges can be expected to delay implementation for at least several more months.

In January 1975, the Administration proposed a number of amendments to the Clean Air Act, including a proposal to consider deletion of the "significant deterioration" requirements.[23] In his message, the President said that "there may be more appropriate ways to deal with the issues associated with significant deterioration" than through the Clean Air Act. He urged the Congress to undertake a prompt and comprehensive review of the issue.[24] The question of a legislative remedy was still before the Congress as this report went to press.

Mobile Sources

A major auto-related air pollution event of the past year was EPA's finding that catalytic converters (fitted with air pumps) can discharge sulfuric acid mists and sulphates at levels significantly higher than uncontrolled automobiles and that these emissions could create a health problem under extreme conditions. Partly as a result of this determination, EPA recommended adjustments in statutory deadlines for reducing auto emissions. Additional amendments were proposed by the Administration later in the year. At the same time, a concerted effort to increase auto mileage and efficiency in order to conserve energy brought further pressure for a reevaluation of auto emission standards.

EPA efforts toward parking management ran into Congressional opposition. Meanwhile, the debate over indirect sources and air quality planning continued as part of the effort by the Congress to review and amend the act.

Although the Clean Air Amendments of 1970 established very specific goals for reducing major pollutants from automobiles, they allowed delays in implementing certain standards. The act also authorized EPA to use its regulatory authority to reduce congestion and auto dependency in urban areas. A number of efforts to use this authority have caused considerable controversy in the intervening years.

Automobile Emission Controls The 1970 amendments required a 90 percent reduction below the 1970 model year levels in HC and CO emissions by the 1975 model year and a similar reduction in NO_x below 1971 model year levels by 1976. The act authorizes the Administrator of EPA to determine—under established criteria—whether to extend each deadline by 1 year. Such an extension was made in April 1973 for the 1975 standards, with interim standards promulgated to replace the statutory requirements. Table 1 compares the original statutory standards with uncontrolled emissions and with various changes and proposed changes.

In 1974 the Congress passed a series of amendments to the Clean Air Act in the form of the Energy Supply and Environmental Coordination Act.[25] For mobile sources this act extends the 1975 HC and CO interim standards through 1976 and also gives the Administrator of EPA authority to prescribe interim standards for 1977 instead of following the statutory standards. The original statutory standard for 1975 will become effective in 1978. The law does not allow for

Table 1

Automobile Emission Standards

(In grams per mile)

	HC	CO	NO_x
Uncontrolled cars (pre-1968) [1]	8.7	87.0	3.5
1970–71 federal standards [2]	4.1	34.0	
1972–74 federal standards [2]	3.0	28.0	3.1
1975 [3] and 1976 [4]			
Federal 49-state standards	1.5	15.0	3.1
California standards	0.9	9.0	2.0
1977 [5] federal 50-state standards	1.5	15.0	2.0
1978 statutory standards	0.41	3.4	.4
Administration bill (January 1975)			
1977–81 50-state standards	0.9	9.0	3.1
Post-1981 50-state standards	(6)	(6)	(6)
EPA recommendation (March 1975)			
1977–79	1.5	15.0	2.0
1980–81	0.9	9.0	2.0
Post-1981	0.41	3.4	(6)
Revised administration proposal (June 1975)			
Through 1981	1.5	15.0	3.1
Post-1981	(6)	(6)	(6)

[1] On the basis of 1975 test procedures.

[2] Imposed administratively by EPA.

[3] Imposed by EPA as interim standards after suspension of statutory standards, except for California's HC and NO_x standards, which were set by the state.

[4] Imposed by Congress in Public Law 93–319, except for California's NO_x standards, which were set by the state[4]

[5] Imposed by EPA as interim standards after suspension of statutory standards, except for NO_x standards, which were imposed by the Congress (Public Law 93–319).

[6] Administrative discretion.

An EPA emission testing facility for new automobiles in Ann Arbor measures engine exhaust.

suspensions of the NO_x standard and sets a new statutory standard for both 1977 and 1978.

In his State of the Union Address on January 15, 1975, President Ford recommended that the auto emission standards be somewhat relaxed in exchange for an effort by the major auto producers to improve fuel efficiency 40 percent by the 1980 model year. In particular, the President called for tightening the nationwide standard for the 1977 through 1981 model years to the level of the 1975 California standards for HC and CO (0.9 grams per mile and 9 grams per mile, respectively) and for holding NO_x at the 1975 nationwide standard (3.1 grams per mile) for those 5 years, except for California, which would be held at 2 grams. These new proposed standards for HC and CO, although representing a pause in moving toward the statutory standards, would still be more stringent than those required nationwide for 1976, thus allowing continued progress toward the 90 percent reduction.

Furthermore, while these goals would have no significant impact on ambient air quality, they would make it easier to achieve the 40 percent increase in mileage being sought.[26] The proposed amendments were sent to the Congress on January 30, 1975, as part of the President's energy message.[27]

That same week, EPA released draft technical reports and information indicating that the problem of sulfuric acid emissions from autos equipped with catalytic converters was serious and could create a public health problem as early as 1978 unless additional regulatory steps were taken. By that time such emissions could outweigh the benefits of HC and CO control attained by the catalysts.[28]

On March 5, 1975, the Administrator exercised his option under the Energy Supply and Environmental Coordination Act to suspend the 1977 auto emission standards and to extend the 1975 interim standards for HC and CO. By law the NO_x standard still had to be reduced from 3.1 to 2 grams per mile for 1977. In addition, he recommended a program for future reductions that differed somewhat from earlier Administration proposals. The new 1977 interim standards would be retained for 1978–79 models, with further reduction in 1980–81 models and achievement of the original reduction goals of the statute by 1982. In addition, a sulfuric acid standard was to be developed for 1979 models.

Calling it "the most unhappy decision EPA has had to make since I've been there," Administrator Train outlined his reasons for the suspension.[29] In addition to the energy conservation considerations cited by President Ford, Mr. Train was influenced by the potential threat to health from sulfuric acid mist emissions. Although the proposed changes would slow progress in meeting Clean Air Act goals, they would continue movement toward them and provide for their eventual attainment. Meanwhile, the suspension would permit further study of the sulfuric acid problem, postponing any increased reliance on catalysts before their effects were known but retaining catalysts as a possible solution to mobile source emissions.

The decision to suspend the 1977 standards and the new schedule of standards proposed to the Congress received both support and criticism. Environmental groups agreed that the sulfuric acid emissions must be controlled but argued that the best way to do this would be to reduce sulfur levels in gasoline. There was some debate over the cost and time required to desulfurize gasoline; EPA estimated a lead time of 3–5 years and considerable investment.

In the summer of 1975 President Ford submitted a revised proposal to the Congress.[30] It would extend the model year 1975 standards through 1981. Standards for model year 1982 and thereafter would be set by the Administrator of EPA, considering air quality, energy efficiency, availability of technology, cost, and other relevant factors. This proposal was based upon concerns over sulfuric acid emissions from catalytic converters; the possibility that other pollutants might be produced by converters; demonstration that more stringent auto emission limitations would not help those metropolitan areas with air pollution problems achieve or maintain the auto-related primary standards; and the conclusion that while not providing significant environmental benefits, they would impact adversely on fuel economy and consumer costs. The proposal was supported by an Energy Resources Council memorandum suggesting analysis of the basic philosophy and approach to future auto emission controls in light of fuel shortages and the need to develop new technologies with efficient fuel use and low emissions and in light of control techniques for other sources of the same pollutants.[31]

In mid-1975, the issue of auto emissions controls was before the Congress. Hearings had been held in both Houses, and the appropriate committees were preparing recommendations as part of their evaluation of the Clean Air Act and its implementation by EPA.

Transportation Control Plans Soon after submission of the state implementation plans, EPA found that special efforts to control mobile sources would be needed to meet ambient air quality standards in thirty-four metropolitan areas.[32] In particular, plans were needed to reduce automobile use and concentration within these metropolitan areas. Where localities and states were unable to come up with an acceptable plan, the Clean Air Amendments directed EPA to develop one.[33]

In some cases, EPA suggested controls on downtown parking and parking taxes to reduce the number of low- or single-occupancy commuter autos. EPA authority to establish transportation control plans was upheld by the Court of Appeals for the First Circuit in September 1974.[34] In that case, based on the Boston transportation control plan, opponents had charged that the Congress had made an unconstitutional delegation of power to EPA, resulting in a taking of property without just compensation.

New York City is one of many cities that will benefit from state transportation control strategies designed to reduce automobile traffic and save energy.

In 1974, the Congress began to restrict conditions under which parking controls could be instituted and enforced. A June amendment to the Clean Air Act forbade EPA to impose taxes or surcharges on parking unless the affected locality agreed.[35] In addition, the EPA appropriation bill for fiscal year 1975 delayed the agency's authority to require parking management plans until July 1, 1975.[36]

Meanwhile, the Administration submitted—as part of its January 1975 package of amendments to the Clean Air Act—a proposal to authorize EPA to grant up to two 5-year extensions of transportation control plan requirements to municipalities that had implemented all reasonable control measures but still failed to meet the standards.[37] Thus the Congress had before it again the question of the extent of EPA's authority to control the number of parking facilities in areas where auto use must be reduced.

Indirect Sources Another issue with respect to mobile sources has been the development of statewide programs for preconstruction review of major facilities that attract large numbers of vehicles and thus may create violations of ambient air quality standards. These "indirect sources"—also referred to as "complex sources"—include shopping centers, stadiums, airports, amusement parks, and urban roadways, among others. The requirement for states to develop a review program to control the siting of indirect sources under EPA regulations derives from a January 1973 Court of Appeals ruling by the District of Columbia Circuit.[38] EPA issued final regulations in February 1974, but federal enforcement of the program was delayed in order to allow the Congress to review the issues.[39] The June 1974 Amendments to the Clean Air Act delayed implementation of the regulations until January 1975.[40]

On December 24, 1974, EPA announced a further 6-month delay in implementing indirect source regulations. In June 1975, the agency declared an indefinite suspension for parking facilities and shopping centers and another 7- to 8-month delay for highways and airports.[41] The delays were attributed to the 1975 appropriations bill prohibition on use of funds to regulate parking facilities, to substantial public misunderstanding over the regulations, and to need by the Congress for an opportunity to review the issue. Meanwhile, a number of states adopted their own indirect source review procedures.

The "indirect source" controversy is a major issue facing the Congress in its review of the Clean Air Act. Critics assert that the Clean Air Act should not affect facilities that do not themselves pollute; it is the autos, they say, not the facilities that should have better controls. They also argue that indirect source controls are in reality a land use regulatory power in the hands of a state air pollution agency, that controls will delay construction, that they will lead builders to opt for smaller facilities or strip development, and that the controls will encourage sprawl and discourage center city development by stimulating location in outlying areas.

Supporters of indirect source controls argue that reviewing the location and design of such major facilities is essential to the maintenance of air quality standards, that most resultant changes will be relatively simple matters of design rather than siting or other land use changes, that the controls can encourage public transit and discourage or increase the efficiency of auto use, that nondegradation rules can be applied to combat sprawl, and that preconstruction review is a less costly solution to air pollution than corrective action after construction.

This Congress is reviewing what should be done about the regulation of indirect sources as part of its effort to amend the Clean Air Act. A recent EPA study discusses a number of these issues and describes their application to certain types of facilities, including shopping centers.[43]

ISSUES TO WATCH FOR

The Congress is in the process of considering revisions to the Clean Air Act in light of new national concerns, including energy conservation and economic recovery, that have surfaced since 1970. While most of the debate will center around familiar issues such as auto emission standards, coal conversion, indirect source controls, significant deterioration, and transportation control plans, a number of new issues are emerging. Chief among these are resolving the apparent conflict between auto emissions and auto efficiency goals, improving air quality planning and accommodating air quality and land use objectives.

Auto Emission and Auto Efficiency

The efficiency of automobiles is related to the size of their engines, their weight, the accessories that they carry, and the degree and type of emission controls required by law. The auto industry has pledged a 40 percent increase in auto efficiency by 1980, provided the government grants sufficient delay in imposition of stricter emission standards. This pledge, however, and the Clean Air Act Amendments proposed by the Administration as a tradeoff for more auto efficiency were based on the assumption of continued use of catalytic converters. The catalyst approach is now under further study by EPA and the industry. In 1975, the first year of extensive use of converters, there was a significant increase in auto efficiency, but the industry claims that much of the advantage would be lost by implementation of stricter standards.

The Congress is reviewing both the proposed emission control amendment to the Clean Air Act and a series of tax and regulatory proposals to stimulate a shift toward more efficient autos. The entire effort is complicated by continuing debate over the extent to which smaller, less powerful cars will in fact produce lower emissions per vehicle mile traveled.

Air Quality Planning

The Clean Air Amendments rely on state implementation plans, especially three components of the plans—controls to meet ambient air standards, air quality maintenance plans, and transportation control plans for communities with special mobile source problems. None of these mechanisms is operating with total effectiveness. Because of changes in the law and regulations brought about by the Congress, the courts, and EPA, no state has a fully approved state implementation plan. Air quality maintenance plans designed to maintain air quality where air meets or is better than ambient air standards are just beginning to be developed. Transportation control plans have been held up by delays in implementing their indirect source and parking control components. In short, there is a need for improvement and better coordination of planning efforts under the act.

Air Quality and Land Use

The Clean Air Act has an undeniable impact on land use. For example, the significant deterioration regulations tend to establish state controls over the siting of all new major industrial facilities, thus putting the states into a land use regulation role through their air quality responsibilities. Air quality goals seek to reduce auto use, and more compact development patterns contribute to this reduction because they are less auto-reliant. Yet compliance with air quality regulations is often more difficult for cities and for large concentrated facilities; the difficulty encourages construction of new facilities away from urbanized areas and in smaller units. This pattern, in turn, stimulates residential development at low densities and a consequent reliance on automobiles.

The complex interrelationships of air quality and land use goals are emerging as a major issue which states and local governments will be facing in the years ahead.

WATER

BACKGROUND

Until 1972, the federal approach to water pollution was defined by the 1948 Federal Water Pollution Control Act (as amended in 1961, 1965, 1966, and 1970)[43] and the Refuse Act of 1899.[44] The FWPCA originally focused on ambient water quality, and allowable discharges were related to the estimated assimilative capacity of the receiving stream or lake.[45] Enforcement was slow and cumbersome, requiring conferences and long waiting periods. As a result, the act's provisions were the basis of only three civil court actions (and no criminal actions) brought against polluters before 1972.[46]

An effective antipollution tool was created when in 1960, a Supreme Court decision held that under the Refuse Act the United States could sue industries to stop them from discharging pollutants into navigable waters.[47] The federal government expanded its activities under this law in 1971 when it brought a total of 250 civil and criminal lawsuits.[48] As interpreted, the Refuse Act required each polluter to obtain a discharge permit from the Corps of Engineers. EPA was later authorized to work with the Corps to create and administer a national permit program for all dischargers.[49] Although the program was never fully implemented,[50] it marked a fundamental change in our pollution control policy—instead of selective enforcement against the worst offenders, all polluters would be regulated under a nationwide permit program.

This change was incorporated into the 1972 Amendments to the Federal Water Pollution Control Act.[51] The act no longer focused on ambient quality and assimilative capacity but instead established discharge requirements, calling upon industrial polluters to achieve the "best practicable treatment control technology, currently available" by 1977 and more stringent "best available technology economically achievable" by 1983.[52] Municipal sewage discharges must receive secondary treatment by 1977 and best practicable waste treatment technology by 1983. The ultimate goal is to eliminate the discharge of all pollutants into navigable waters by 1985.[53] Each discharger must obtain a permit which limits, item-by-item, the amount of pollution that may be discharged.[54] The amendments also provide for regulating toxic pollutants.[55]

The 1972 amendments greatly increased the amount of federal aid available to local governments for constructing municipal waste

"It is the national goal that . . . water quality which provides for the protection and propagation of . . . wildlife . . . be achieved by July 1, 1983" (P.L. 92–500).

water collection and treatment systems. The original 1948 act had authorized loans, but monies were never appropriated. Federal involvement increased with subsequent amendments, however, so that by 1971 municipal grants covered up to 55 percent of construction costs and annual appropriations were running at $1 billion.[56] The 1972 amendments increased the federal share to 75 percent, and the Congress authorized $18 billion over a 3-year period.[57]

The nation has had 3 years of experience with the 1972 amendments and is beginning to understand better the problems and advantages of the new approach. We are now at a point when perceptive analyses of the legislation's impact are particularly important. We still have the flexibility to correct our course, but delay could be very costly. Several analyses of the legislation's implementation were undertaken during the past year. They will provide the basis for possible amendments to be considered during the coming year.

EVENTS OF THE PAST YEAR

A recent House subcommittee staff report observed that Public Law 92–500 underestimated the task to be done and overestimated the results that could be expected.[58] The act requires myriad administrative actions and regulations and requires EPA to:

- Define acceptable treatment technologies
- Establish and enforce water effluent standards for most sectors of the economy
- Issue permits for all point sources
- Establish and carry out various types of planning mechanisms
- Administer what has become, after highways, the second largest public works program in the nation.

All this was to be accomplished within a very short time. Notwithstanding the many difficulties encountered and deadlines missed. EPA's implementation continues to progress.

Effluent Guidelines

Effluent guidelines establish nationally applicable waste water treatment criteria for best practicable (1977) and best available (1983) treatment technologies. They are the basic criteria for issuing discharge permits to industrial polluters. For the purpose of issuing effluent guidelines EPA has divided industrial categories into three groups. "Group I Phase I" includes those basic 28 identified in the 1972 amendments.[59] The Group I guidelines are complete (see Table 2), but they have been challenged in over 150 lawsuits, mostly by the industries affected.

Another 38 industrial categories (with 233 subcategories) were incorporated into the program as a result of a court decision, which also set dates for the promulgation of these new guidelines.[60] The

Table 2

Status of Effluent Guidelines, June 1975

Industry groups	Number of subcategories	Court ordered date for promulgation[1]	Date proposed[2]	Date promulgated[2]	Lawsuits
Group I, Phase I					
Fiberglass	1		8-22-73	1-22-74	1
Beet sugar	1		8-22-73	1-31-74	1
Feedlots	2		7-7-73	2-14-74	1
Glass	6		9-7-73	2-14-74	1
Cement	3		9-7-73	2-20-74	1
Phosphate	3		10-17-73	2-20-74	3
Rubber	4		10-11-73	2-21-74	5
Ferroalloy	3		10-18-73	2-22-74	1
Asbestos	7		10-5-73	2-26-74	1
Meat	4		10-30-73	2-28-74	3
Inorganics	22		10-11-73	3-12-74	22
Cane sugar	2		10-29-73	3-20-74	4
Grain mills	6		10-11-73	3-20-74	3
Fruits and vegetables	5		11-30-73	3-21-74	3
Electroplating	1		12-7-73	3-28-74	3
Plastics and synthetics	13		11-9-73	4-5-74	12
Nonferrous	3		12-4-73	4-8-74	2
Fertilizers	5		12-26-73	4-8-74	20
Leather tanning	6		4-8-73	4-9-74	2
Soap and detergent	19		12-14-73	4-12-74	—
Timber products	8		12-20-73	4-18-74	2
Organic chemicals	3		12-7-73	4-25-74	12
Petroleum refining	5		1-15-74	5-9-74	5
Builders paper	1		12-17-73	5-9-74	—
Dairy	11		1-14-74	5-28-74	—
Pulp and paper	5		2-6-74	5-29-74	12
Seafood	14		1-3-74	6-26-74	—
Iron and steel	12		2-19-74	6-28-74	5
Textiles	7		2-5-74	7-5-74	2
Steam electric	4		3-4-74	10-8-74	28
Group I, Phase II					
Glass	6	11-15-74	8-21-74	1-16-75	
Rubber	7	11-12-74	8-23-74	1-10-75	
Meat	6	12-4-74	8-28-74	1-3-75	
Timber	7	11-12-74	8-26-74	1-16-75	
Asbestos	4	11-22-74	8-29-74	1-9-75	
Grain mills	4	12-5-74	9-17-74	1-3-75	
Plastics and synthetics	11	12-2-74	9-20-74	1-23-75	
Fertilizer	2	12-30-74	10-7-74	1-14-75	
Phosphates	3	1-8-75	1-27-75[3]		
Ferroalloys	5	1-20-75	2-24-75[3]		
Poultry	5	—	4-24-75[3]		
Inorganics	41	1-31-75	5-22-75[3]		
Seafoods	19	1-15-75	1-30-75[3]		
Cane sugar	5	1-31-75	2-27-75[3]		
Nonferrous	5	1-31-75	2-27-75[3]		
Electroplating	3	1-31-75	4-24-75[3]		
Organics	4	7-1-75			
Fruits and vegetables	51	10-15-75			
Pulp and paper	10	9-15-75			
Iron and steel	23	7-1-75			
Foundries					
Carbon and alloy					

See footnotes at end of table.

Table 2—Continued

Status of Effluent Guidelines, June 1975

Industry groups	Number of subcategories	Court ordered date for promulgation	Date proposed [2]	Date promulgated [3]	Lawsuits
Group II					
Furniture	4	3-24-75	4-14-75	6-2-75	
Asphalt paving	4	4-12-75	1-10-75		
Paint and ink	4	5-12-75	2-26-75		
Auto and other laundries	6	—			
Fish hatcheries	3	—			
Transportation	7	—			
Converted paper	—	—			
Petroleum and gas extraction	4	9-1-75			
Steam supply	2	—			
Coal mining	4	10-6-75			
Water supply	15	—			
Mineral mining	25	10-5-75			
Miscellaneous chemicals	8	12-1-75			
Ore mining and dressing	11	11-15-75			
Foods and beverages	66	—			
Clay and gypsum	11	—			
Machinery and mechanical products	15	12-15-75			
Concrete products	3	—			

[1] *Natural Resources Defense Council* v. *Train*, 7 ERC 1209 (1974).
[2] Published in *Federal Register*.
[3] Interim Final Guidelines.
Source: Based on Environmental Protection Agency, unpublished data.

additional industries were divided into two categories, "Group I, Phase II" industries, and "Group II" industries. For both, the final guidelines were to have been published by the end of 1974, but the court gave EPA permission to apply for an extension of this deadline. In fact, as indicted in Table 2, publication of the Group I, Phase II guidelines was incomplete and only one of the Group II final guidelines had been published by the end of June 1975.

In addition to the guidelines regulating direct discharges into the nation's waters, industrial discharges into municipal sewage systems are subject to another set of regulations to ensure that these effluents do not disrupt the system.[61] The progress achieved in issuing these "pretreatment" regulations is shown in Table 3.

Each set of effluent guidelines also includes specific performance standards for new sources—e.g., new industrial plants or substantial expansions of existing plants. New source performance standards are defined as the best available demonstrated control technology, including, where possible, no discharge of pollutants. These new source standards are generally the same as the 1983 standards.

Table 3

Pretreatment Guidelines [1]

Industry	Sub-categories	Proposal date	Promulgation date	Promulgation date for exceptions
Fiberglass	1	1-22-74	—	—
Beet sugar	1	1-31-74	2-11-75	—
Feedlots	2	2-14-74	2-11-75	—
Glass	[2] 6	2-14-74	2-11-75	3-28-75
Cement	3	2-20-74	2-11-75	—
Phosphate	3	2-20-74	—	—
Rubber	4	2-21-74	—	—
Ferroalloy	3	2-22-74	—	—
Asbestos	7	2-26-74	2-11-75	—
Meat	4	2-28-74	2-11-75	—
Inorganics	22	3-12-74	—	—
Cane sugar	2	3-20-74	2-11-75	—
Grain mills	6	3-20-74	2-11-75	—
Fruits and vegetables	5	3-21-74	2-11-75	—
Electoplating	1	3-28-74	—	—
Plastics and synthetics	13	4-5-74	—	—
Nonferrous	3	4-8-74	—	—
Fertilizer	5	4-8-74	—	—
Leather tanning	6	4-9-74	—	—
Soap and detergents	[3] 19	4-12-74	2-11-75	3-28-75
Timber	8	4-18-74	—	—
Organics	[4] 3	4-25-74	2-11-75	4-30-75
Petroleum refining	5	5-9-74	—	—
Builders paper	1	5-9-74	2-11-75	—
Dairy	12	5-28-74	2-11-75	—
Pulp and paper	5	5-29-74	2-11-75	—
Seafood	14	6-26-74	2-11-75	—
Iron and steel	12	6-28-74	—	—
Textiles	8	7-5-74	—	—
Steam electric	1	10-8-74	—	—

[1] Dates given are publication dates in the *Federal Register*.

[2] With two exceptions.

[3] With four exceptions.

[4] With three exceptions.

Whether a facility is deemed an existing source or a new source is important for two reasons. First, new source performance standards are for the most part stricter than 1977 standards for existing sources because it is assumed that the latest technology is more easily built into a new facility. Second, the new source permit is issued for a longer period than other permits, thus reducing the potential for periodic tightening of permitted effluent levels. EPA has to prepare and circulate environmental impact statements on major new source permit actions and in the process should review all aspects of the siting decision for the source.[62]

The NPDES Permit Program

Section 402 of the Federal Water Pollution Control Act provides for a national pollutant discharge elimination system (NPDES) and requires point sources discharging pollutants into waters of the United States to have obtained a discharge permit by December 31, 1974. By July 1 of this year, over 40,000 permits had been issued, as shown in Table 4. The emphasis was on "major" industrial and municipal discharges, with 95 percent of these applications processed. A lag occurred mainly with the "minor" industrial polluters—only 67 percent of applications had been processed. No prosecutions have been brought against any dischargers who have not received permits because of the backlog.

Permits are good for up to 5 years. They include a detailed breakdown of pollutants allowed and a compliance schedule for achieving "best practicable" and "best available" waste water treatment.

A major problem in issuing permits relates to the definition of new sources. EPA has begun to accept applications for new source permits and has made some determinations on whether a facility is a new source, but no permits have yet been issued.

In many states, state agencies will assume responsibility for issuing permits as they develop acceptable implementation and enforcement mechanisms. Their doing so relaxes some of the pressure on EPA and places the review function in the hands of people who have more direct knowledge of the discharger and of local water quality. However, EPA still retains a right to prevent the issuance of any permit within 90 days of notification.[63] By July 1975, 24 states had taken over the permitting functions. They are listed in Table 5.

Two recent court rulings could substantially expand NPDES activity. One was a district court finding that permits were required for many sources which had been categorized by EPA as nonpoint.[64]

Table 4

Status of Permits Required under the National Pollution Discharge Elimination System, June 1975

	Applications received	Permits issued
Industrial		
Major	2,863	2,797
Minor	29,086	17,294
	31,949	20,091
Municipal		
Major	2,930	2,714
Minor	17,745	13,950
	20,675	16,664
Agricultural	6,414	1,548
Federal facilities		1,988
Total	59,038	40,291

Source: Environmental Protection Agency.

Table 5

States Assuming National Pollution Discharge Elimination System Responsibilities

State	Date assumed
California	May 14, 1973
Oregon	September 26, 1973
Connecticut	September 26, 1973
Michigan	October 17, 1973
Washington	November 14, 1973
Wisconsin	February 4, 1973
Ohio	March 11, 1974
Vermont	March 11, 1974
Delaware	April 1, 1974
Mississippi	May 1, 1974
Montana	June 10, 1974
Nebraska	June 12, 1974
Georgia	June 28, 1974
Kansas	June 28, 1974
Minnesota	June 30, 1974
Maryland	September 5, 1974
Missouri	October 30, 1974
Hawaii	November 28, 1974
Indiana	January 1, 1975
Colorado	March 27, 1975
Wyoming	January 30, 1975
Virginia	March 31, 1975
South Carolina	June 10, 1975
South Dakota	June 13, 1975

Source: Environmental Protection Agency.

A second decision by the same court ordered the Corps of Engineers to expand the definition of navigable waters in its regulations implementing section 404 of the act.[65] The first of these is discussed in the last part of this section on water quality, the second in the water resources section of the chapter.

Enforcement

Under the FWPCA Amendments of 1972, administrative warnings and enforcement orders are established as the primary measures to seek compliance with provisions of the act or with provisions of a federal or state discharge permit.[66] The Administrator may also seek judicial enforcement through federal civil and criminal lawsuits. The U.S. Coast Guard has primary enforcement authority under section 311, "Oil and Hazardous Substance Liability," and can assess civil penalties of up to $5,000. Table 6 shows the federal government's enforcement history under the Water Pollution Control Act (both before and after the 1972 amendments) and under the Refuse Act. In 1971 and 1972, the peak years of Refuse Act enforcement, 517 civil and criminal actions were brought against polluters. Fewer judicial actions were initiated in 1973 and 1974 because the 1972 amendments created an enforcement hiatus—no polluter who had

Table 6

Federal Enforcement Actions, Fiscal Years 1967–75

	1967	1968	1969	1970	1971	1972	1973	1974	1975
Refuse Act									
Criminal actions filed	56	41	46	129	191	198	106	38	8
Convictions	(1)	(1)	42	59	127	130	86	52	(1)
Civil actions filed	0	0	0	2	58	68	36	5	7
Settlements and decrees	0	0	0	0	24	29	9	19	(1)
Federal Water Pollution Control Act									
Criminal actions filed (excluding section 311 oil spills)						0	0	1	1
Convictions						0	0	0	1
Civil actions filed (excluding section 311 oil spills)						2	0	2	52
Settlements and decrees								2	17
Section 311 oil spill cases disposed of by fine or penalty (new act)							3,346	2,448	(1)
median find							$1,135	$867	(1)
Enforcement conferences and 180-day notices (old act only)	9	9	10	32	30	177	0		
Administrative orders (new act only)							0	165	322

[1] Not available.

Source: Environmental Protection Agency, Department of Justice, and U.S. Coast Guard data; Environmental Protection Agency, *EPA Enforcement: Two Years of Progress* (Washington, D.C., 1975).

applied for a permit under the FWPCA provisions could be prosecuted before December 31, 1974.[67]

EPA initiated another enforcement mechanism during this past year; with assistance from the states, EPA will list facilities in violation of the FWPCA.[68] While so listed, the facilities will be cut off from federal contracts, subcontracts, grants, subgrants, loans, or subloans except for the purpose of pollution abatement. Every facility, however, will be given an opportunity to consult with EPA before being formally listed.

Municipal Pollution

Title II of the act pertains to water pollution control from municipal sewage systems. The 1972 amendments called for all municipal systems to provide the equivalent of secondary treatment by July 1, 1977, authorized $18 billion for federal aid for municipal systems, increased the federal share to 75 percent, and expanded the definition of facilities that were eligible for this aid. Nine billion of the $18 billion authorized was impounded between 1973 and 1975. President Ford released $4 billion in January 1975 and the remainder in March after the Supreme Court overruled the original impoundment.[69]

By the end of fiscal year 1975, approximately $6.6 billion of these funds had been obligated and $1 billion actually spent. As indicated in Figure 1, annual obligations are increasing, and the total $18 billion authorization is expected to be obligated by September 1977.

Federal aid is available for planning, design, and construction. Table 7 shows the substantial number of projects that have been and are expected to be funded under the 1972 amendments. By the end of fiscal year 1977, an estimated 1,500 projects will be complete, with 4,785 additional projects under construction and 3,800 still in the first and second stages.

In the past year there have been several studies of the implementation and impacts of the construction grants program. The Environ-

Table 7

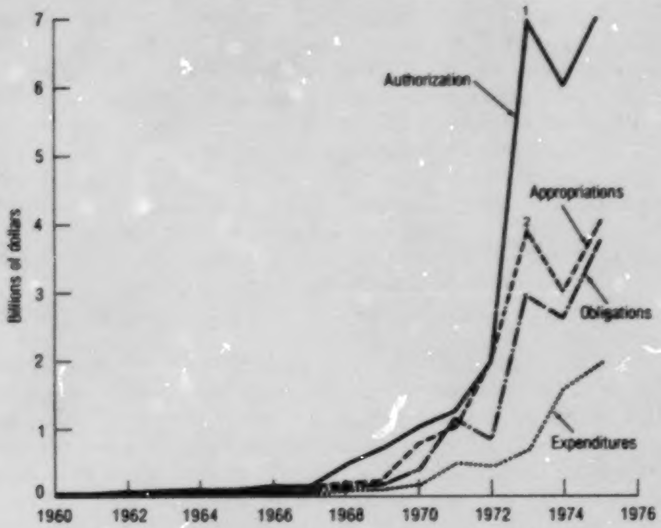
Expected Progress for Municipal Sewage Projects

Status of projects	1975	1976	1977
Under planning	3,120	2,800	1,300
Under design	1,830	2,700	2,500
Under construction	3,675	4,035	4,785
Completed	900	1,200	1,500

Source: Based on Environmental Protection Agency, Construction Grants Review Group, *Review of the Municipal Waste Water Treatment Program* (Washington, D.C., 1974), p. 54.

Figure 1

Status of Construction Grants Funding, July 1975



Fiscal year				
	Annual authorization	Annual appropriation	Annual obligations	Annual expenditures
1957	50	50	38	1
1958	50	46+	47	17
1959	50	47+	46	36
1960	50	46+	48	40
1961	50	46+	45	44
1962	80	80	64	42
1963	90	90	92	52
1964	100	90	85	66
1965	100	90	84	70
1966	150	121	118	81
1967	150	150	131	84
1968	450	203	191	122
1969	700	214	201	135
1970	1,000	800	424	178
1971	1,250	1,000	1,152	478
1972	2,000	2,000	860	413
1973	7,000[1]	3,900[2]	2,989	684
1974	6,000	3,000	2,625	1,553
1975	7,000	4,000	3,758	1,956

[1] Includes $2 billion for reimbursement to municipalities for prior construction.
[2] Includes $1.9 billion for reimbursement to municipalities for prior construction.
Source: Environmental Protection Agency, *Review of the Municipal Waste Water Treatment Works Program*, 1974

mental Protection Agency,[70] the Council on Environmental Quality,[71] the National Commission on Water Quality,[72] and the National Utility Contractors Association[73] have studied such issues as the cost effectiveness of designs, the impacts of grants on land use, the institutional problems of administering the program, and the relationships between construction grants and the various planning requirements in the law (sections 208, 303, and 201). EPA has now issued a second edition of its "Guidance for Facilities Planning," reflecting many of the concerns expressed in these and other studies.[74]

Cost Effectiveness Several studies related to whether projects being funded by EPA are cost effective. One EPA study reported on 11 projects whose original design had been reviewed and modified.[75] These modifications saved nearly 20 percent on the initial investment, and for 7 of the projects (for which annual O&M costs were available) over 10 percent on O&M costs as well.

The General Accounting Office report focused on one project analyzed in a series of workshops which found that more cost effective design would reduce both initial investment costs and annual operating costs by about 30 percent.[76] In reviewing approximately 100 other projects, the study indicated the possibility of achieving widespread cost savings by implementing the principles recommended in the report.

The basic design criteria used by engineers in designing waste treatment facilities were also questioned. A study sponsored by CEQ, "Interceptor Sewers and Suburban Sprawl," concluded that interceptor sewer designers were often using excessive population growth rates and high per capita sewage generation rates and were planning too far in the future.[77] All three factors contributed to substantial excess capacity in the facilities—a waste of limited investment funds.

An independent EPA report agreed that the optimal planning period for treatment plants and interceptor sewers is approximately half that typically used in their design.[78]

Fiscal Integrity A second area of controversy was whether the grants program was maintaining adequate fiscal integrity. An EPA review observed that there are potential problems of fraud.[79] A subsequent audit concluded that some grants "are not being administered effectively" [80] and questioned $13 million (out of $120 million) of costs incurred by 12 states in 41 projects. The largest amounts were traceable to apparently excessive profits by engineering firms and to defective construction. The report recommended more careful project review and inspection and tighter regulations for procuring engineering services.

Environmental Impacts The problem of potential adverse environmental impacts was also raised. EPA's program review analyzed 43 projects for which no environmental impact statement had been prepared. In no case had an adequate environmental assessment been undertaken prior to making a "negative declaration." [81]

The CEQ study of 52 interceptor sewer projects found many serving large amounts of vacant land.[82] As a result, they could generate significant indirect adverse environmental impacts, the kind that typically are not even considered while a project is being designed or reviewed. These "secondary impacts," as they are often called, are sometimes of greater magnitude than the primary effects of an action.

In particular, extending interceptor sewerlines into previously undeveloped areas on a large scale tends to exacerbate problems of sprawl and leapfrog development patterns by simultaneously opening large amounts of land to residential development. These impacts are especially severe when the sewer extensions into such areas have not been coordinated with local and regional planning and programming for other necessary services. The low-density developments which follow tend to create runoff and erosion problems and to increase reliance on autos, with resultant problems of air pollution and gasoline consumption.

Some secondary impacts issues were addressed in EPA's regulations issued in April for the preparation of environmental impact statements.[83] Subpart E of the regulations concentrates on the waste water treatment grants program and prohibits awarding design or construction grants (excepting for certain "noncontroversial" project segments) until the environmental assessment is complete. The regulations call for preparation of environmental impact statements where significant secondary impacts (such as those described above) may occur. EPA's planning guidelines also recognize the possibility of such adverse secondary effects.[84]

Accelerated Obligations Concerns about improved cost effectiveness, financial integrity, and environmental assessment run concurrently with another very strong concern—that the program is not proceeding fast enough. The data on project grants summarized in Table 7 indicate clearly that the 1977 statutory deadline for installing secondary treatment will not be met. Studies by EPA, the National Commission on Water Quality, and the National Utility Contractors Association essentially agree on the basic reasons for the delay—the

Billions of dollars are being invested in waste treatment facilities such as those at Blue Plains, Washington, D.C.

administrative procedures are too complicated and there are too few people to process grants.[85] The solutions to these problems are less easily agreed upon. Three hundred people are being added to the EPA staff responsible for processing grant applications, but even with this staff expansion, many observers believe that the states will have to take a larger part in the grant certification process.

This change is the focus of a proposed amendment to the Federal Water Pollution Control Act that would authorize EPA to delegate many more responsibilities for certifying municipal grants to the states.[86] The amendment would also allow states to use some of their grant money to pay the resulting higher administrative costs. But even with the funds, most states will need time to develop the capacity to take over the delegated functions.

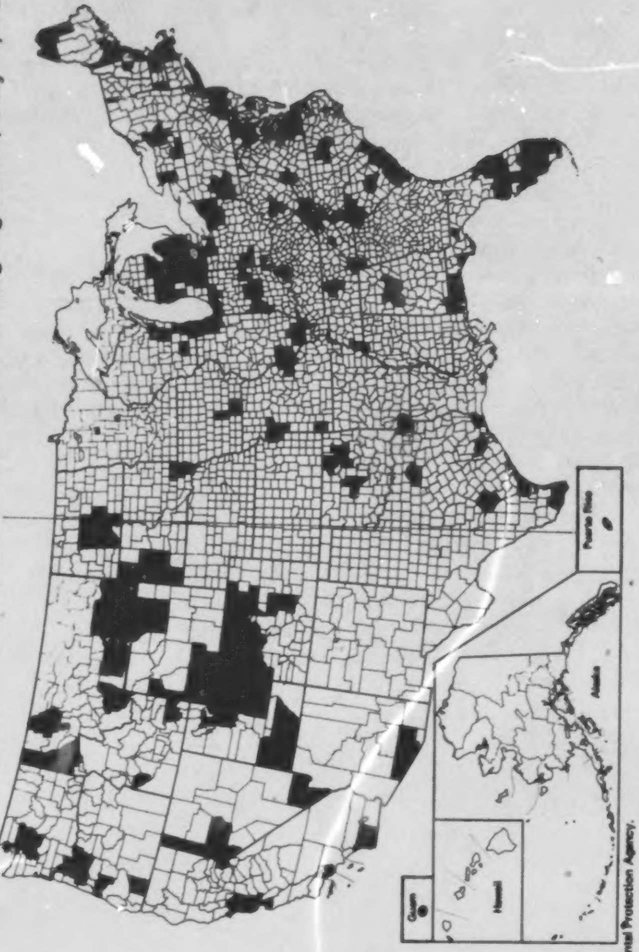
Planning Although delegating certification authority to the states may accelerate the rate at which grant monies are disbursed, it will not necessarily improve the economic efficiency or the environmental integrity of the program. EPA is attempting to deal with these problems through its project design guidelines.[87] The revised guidelines provide more explicit instructions on cost effective design, environmental evaluations, and project review by the public and by state and local planning bodies. They also attempt to coordinate design of a facility with the three sections of the act having planning requirements.

Section 201 pertains to the planning of individual facilities. Section 303e pertains to statewide planning efforts and is designed to encourage the states to develop an overall strategy for water quality improvement, including industrial and municipal waste water discharges. And Section 208 calls for areawide waste treatment and water management plans that incorporate abatement facilities, land use, and economic growth considerations in covering metropolitan areas and other regions.

Most activity in the last year was directed toward implementing section 208. State Governors are responsible for designating areawide 208 planning agencies which, after EPA review and approval, may receive planning grants. The law calls for EPA to cover all the planning costs in fiscal year 1975, but only 75 percent in fiscal year 1976. By June 30, 1975, 149 planning agencies had been designated and awarded grants. The locations are shown in Figure 2.

Several questions have been raised about the section 208 planning process. One concerns the relationship between section 208 plans and section 201 facilities plans. The use of section 208 plans to ensure cost effective and environmentally sound facilities is hindered by the failure of the legislation to require EPA or grant applicants to conform their projects to the section 208 plan until a plan (either interim or final) is complete and has been approved by EPA. As mentioned above, the planning process, which is expected to take an average of 2 years, is just getting underway. A large portion of the treatment system grants will have been obligated before section 208 plans are

Figure 2 Location of Section 208 Planning Agencies, July 1, 1975



Source: Environmental Protection Agency.

ready to be used to determine how and where the money should be spent.

A second question regards the authority that the section 208 agencies will have over land use. Some requirements of the section, particularly those pertaining to the control of such "nonpoint" pollution sources as urban storm water runoff, imply a strong role in controlling land use. But such a role would be controversial because it would be in conflict with prerogatives traditionally exercised by local governments.

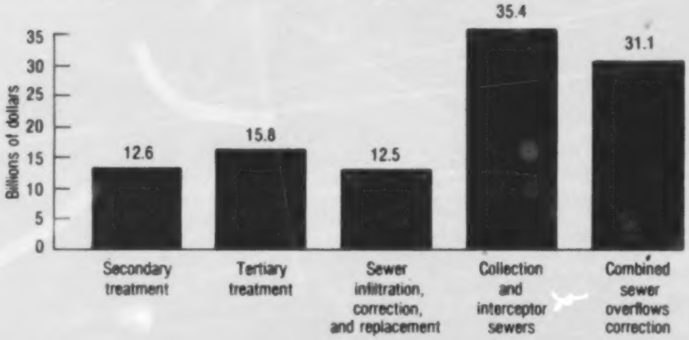
A third question relates to the integration of section 208 and other plans—the HUD 701 comprehensive plans, the Coastal Zone Management Program, state implementation plans called for by the Clean Air Act, and metropolitan area transportation plans. In March 1975, HUD and EPA agreed to coordinate section 701 and section 208 planning efforts, and other such agreements may also be worked out. Serious consideration is being given to expanding 208 plans to include air pollution and solid waste management as well.[88]

A fourth question, resolved during the past year, was whether there would be any section 208 planning requirements for areas where a Governor had not designated a 208 planning agency. The decision in *Natural Resources Defense Council* v. *Train* determined that each state will be responsible for section 208 planning for all such areas.[89]

Needs, Priorities, and Eligibilities The section 208 and other planning requirements are seen as most important elements in promoting efficient (both economically and environmentally) planning for waste water treatment facilities. But even if each plan were efficient, there remains the problem of how the limited federal funds are to be allocated among facilities. In a 1974 survey, the states identified $342 billion in "needs" for waste water control facilities.[90] Two-thirds ($235 billion) of these funds would be used for controlling storm water discharges. Figure 3 shows the breakdown of the other $107 billion. With only approximately $12 billion of federal aid remaining available, the fundamental question is how the money should be allocated to achieve the most improvement in water quality.

Figure 3

Summary of 1974 Needs Survey



Source: Environmental Protection Agency, "Cost Estimates for Construction of Publicly Owned Wastewater Treatment Facilities: 1974 'Needs' Survey," final report to the Congress, February 10, 1975, revised May 6, 1975.

At present, each state develops a priorities list in which possible projects are ranked on the basis of such criteria as population served, seriousness of the pollution problem, need for preservation of high water quality, and national priorities. These lists are supposed to be used to determine how available federal funds should be allocated to individual projects, but many states deviate from their listing, for example, in order to favor projects already in the planning or design stages or to distribute grant funds widely through the state.

How to make better use of federal funds has been the subject of recent hearings in four cities—Atlanta, Kansas City, San Francisco, and Washington, D.C.[91] The hearings focused on proposals to amend the 1972 law to:

- Reduce the federal share of costs
- Limit federal funding to currently needed capacity
- Restrict the types of projects eligible for federal cost sharing.

The hearings also considered proposals for extending the compliance deadline for municipalities beyond July 1977 and for delegating certification authority to the states. As might be expected, consultants and municipalities expressed opposition to the first three proposals listed above. Environmental groups generally supported limiting the capacity of new facilities.

The National Commission on Water Quality

Section 315 of the 1972 amendments called for a national study commission to "make a full and complete investigation and study of all the technological aspects of achieving and all aspects of the total economic, social, and environmental effects of achieving or not achieving the effluent limitations and goals set forth for 1983" by the act.

The National Commission on Water Quality has awarded over $11 million for more than 100 studies pertaining to both the 1977 and 1983 requirements of the legislation. (See Table 8 and Figure 4.) The commission is using the results of these studies to prepare its recommendations and final report which are expected early in 1976.

Safe Drinking Water

The Safe Drinking Water Act, effective December 16, 1974, established a program for protecting the nation's drinking water.[92] To be implemented by EPA, the act calls for primary drinking water standards for substances which may have any adverse effect on the health of persons. These were proposed in March 1975 and were to have been promulgated in interim form by June 1975 to take effect in December 1976. The final regulations, however, are not scheduled to be promulgated before September 1977 (after a special NAS study is complete). Secondary standards address nonhealth-related problems such as disagreeable taste and odor and were scheduled to be proposed by September 1975 and promulgated by December 1975. Although EPA will be responsible for establishing national regulations, individual states which establish approved programs are to assume primary implementation and enforcement authority.

To protect underground drinking water supplies, the act also gave the Administrator of EPA immediate authority to prohibit new underground waste water disposal in areas which rely upon an aquifer as a principal drinking water source. The injection of industrial waste waters deep into the earth is a common practice, particularly

Table 8

Studies Sponsored by the National Commission on Water Quality, June 1975

(In thousands of dollars)

Category and contract area	Dollar amounts
Technology—industry	
Iron and steel	220
Organic and inorganic chemicals	333
Petroleum refining	168
Pulp and paper	173
Electroplating	187
Fruits and vegetables	182
Plastics and synthetics	170
Textiles	168
Stream electric power	184
General industry	377
Technology—municipal	
Wastewater treatment	448
Municipal costs	78
Local Agency needs	2
Water savings	7
Technology—urban runoff	83
Technology—innovative	65
Technology—agriculture	
Point and nonpoint	125
Feedlots	50
Task force	13
Technology—nonpoint sources	
Treatment and policies	35
Economic—micro	
General industries	201
Chemicals, plastics, drugs, and paints	193
Iron and steel, textiles, petroleum refining, pulp and paper	379
Fruits and vegetables, feedlots, meat and dairy, grain, leather, fertilizers	175
Steam electric power	71
Municipal	120
Economic—macro	
Economic modeling	327
Incidence	92
International trade	115
Miscellaneous	51
Economic—special issues	
Financial markets	25
State and local financing	69
Economic—benefits	
National recreation	193
Beach closings and re-openings	99
Property value	141
Commercial fisheries	75
Social—social impacts	232
Environmental—river reach [1]	
Site 1	49
Site 2 (Boston Harbor, Charles)	69
Site 3	56
Sites 4, 5	103
Site 6 (Potomac)	15
Sites 6, 8, 18	112
Site 7 (Yadkin-Peedee)	52
Site 9 (Chesapeake Bay)	59
Site 10 (Lower Mississippi)	65
Sites 11, 28	102
Sites 13, 15	80
Sites 13, 15, 8	69
Sites 12, 16, 27	170
Site 14	75
Sites 17, 19, 20, 21, 22 23, 29	311
Sites 19, 20	69
Site 25 (Illinois)	50
Site 26 (Utah Lake)	50
Site 29	50

See footnote at end of table.

Table 8—Continued

Category and contract area	Dollar amounts	Category and contract area	Dollar amounts
Environmental—special studies		Regional assessment [1]	
Residual disposal	230	Study design	22
Lakes and impoundments	50	Merrimack-Nashua	191
Commercial fisheries	33	Hudson	70
Water quality modeling	59	Delaware and Delaware Bay	225
Municipal effluents	30	Ohio	201
Miscellaneous	159	Kanawha	225
Institutional		Lake Erie	285
Planning	108	Chattah-Flint-Apalachicola	200
Construction grants program	161	Houston Ship Canal-Galveston Bay	263
Permit system	127	Yellowstone	200
Compliance monitoring	71	Colorado	225
Enforcement	128	San Francisco Bay-Central Valley	275
Public participation	80	Puget Sound and Lake Washington	215
Attitudes	119		
Legal issues (statutory authority)	25		
Problems of doers	31		

[1] For locations of various sites, see Figure 4.

Source: National Commission on Water Quality.

since passage of the 1972 Amendments to the FWPCA and the Ocean Dumping Act, both of which inhibit other methods of disposal. At the same time there is a growing tendency for localities to use deep aquifers for their domestic water supplies. Eventually each state will have a permit program to assure that no underground injection will endanger drinking water sources.

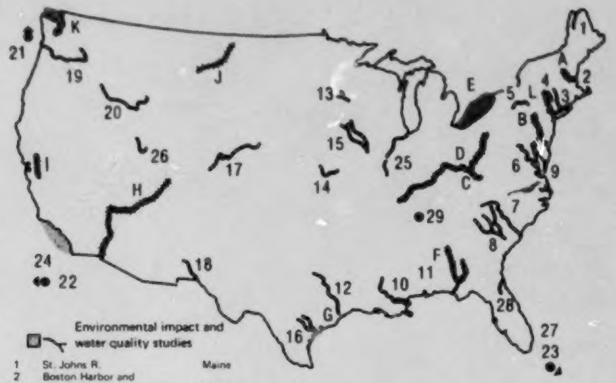
Potentially the most controversial provision of the act is section 1424(e), which provides the Administrator of EPA with authority to declare that an aquifer is a sole or principal drinking water source, contamination of which would create a significant hazard to public health. If such a declaration is made, no federal financial assistance will be available for any projects (e.g., highways or sewers) that may result in the contamination of the aquifer. The procedures for carrying out this section of the act are being developed by EPA, which plans to rely on the environmental impact statement process to identify and evaluate federally assisted projects in declared aquifer areas.

Ocean Dumping

The Ocean Dumping Act of 1972, as amended, regulates ocean dumping by U.S. ships and other ships leaving U.S. ports.[93] EPA has jurisdiction over all materials except dredge and fill, for which jurisdiction remains with the Secretary of the Army.[94] The Coast

Figure 4

Water Sites and Regions under Study by the National Commission on Water Quality



Environmental impact and water quality studies

1	St. Johns R.	Maine
2	Boston Harbor and Charles R.	Mass.
3	Connecticut R.	Mass., Conn.
4	Housatonic R.	Mass.
5	Susquehanna R.	N.Y.
6	Potomac R.	Va., Md.
7	Yadkin–Peedee R.	N.C., S.C.
8	Santee R.	S.C.
9	Chesapeake Bay	Md., Del., Va.
10	Lower Mississippi R.	Miss., La.
11	Escambia Bay	Fla.
12	Trinity R.	Tex.
13	Minnesota–Mississippi, St. Croix conflux	Minn., Wis.
14	Lower Missouri R.	Kans., Mo.
15	Iowa–Cedar R.	Iowa
16	San Antonio R. and Guadalupe R. Basins	Tex.
17	S. Platte R.	Colo., Neb.
18	Upper Rio Grande R.	N. Mex., Tex.
19	Columbia R.	Oreg., Wash.
20	Snake R.	Idaho, Oreg.
21	Gulf of Alaska	Alaska
22	Hawaiian islands	Hawaii
23	Puerto Rico	P.R.
24	S. Calif. Bight	Calif.
25	Illinois R.	Ill.
26	Utah Lake–Jordan R.	Utah
27	Biscayne Bay, Atlantic	Fla.
28	St. John's R.	Fla.
29	Priest Reservoir	Tenn.

■ Regional assessment studies

A	Merrimack – Nashua R.	N.H., Mass.
B	Delaware Bay	Del., Pa.
C	Kanawha R.	W. Va.
D	Ohio R.	Pa., W. Va., Ohio, Ind., Ill., Ky.
E	Lake Erie	Ohio, Pa., N.Y.
F	Chattahoochee – Flint – Apalachicola	Ga., Ala., Fla.
G	Houston Ship Channel – Galveston Bay	Tex.
H	Colorado R.	Ariz., Utah, Nev., Colo., Wyo., Calif.
I	S.F. Bay – Central V.	Calif.
J	Yellowstone R.	Mont., Wyo., N. Dak.
K	Puget S. – Lake Wash.	Wash.
L	Hudson R.	N.Y.

Source: National Commission on Water Quality, February 1975.

Guard has surveillance duties to prevent unlawful dumping.[95] EPA's goal is to stop all dumping activities within the next several years. However, in 1974 ocean dumping increased almost 20 percent. Sewage sludge and construction and demolition debris were the materials primarily making up the increase, as shown in Table 9. New York and Philadelphia account for most of the sludge dumping, although some sludge is discharged through ocean outfalls, particularly on the west coast.[96]

In May 1975, EPA held formal hearings regarding its order that Philadelphia stop dumping sludge (150 million gallons annually) into the Atantic Ocean by January 1, 1981.[97] Having planned to increase the amount as its sewage treatment facilities are upgraded, Philadelphia maintained that inadequate evidence existed to show

In 1974, ocean dumping, particularly of sewage sludge from Philadelphia and New York, increased substantially. This is a New York City sludge vessel.

any harmful effects of the dumping.[98] EPA stated that the sludge contained large amounts of cadmium and mercury and that alternative disposal methods were available, most usefully as low-grade fertilizer or for restoring strip mined lands.

Another major controversy concerns sludge disposal in the New York Bight, which lies south of Long Island, with citizens fearing that the sludge is creeping toward the Long Island beaches.[99] Over 100 separate municipalities now use the area as an ocean dump. In cooperation with NOAA, EPA is conducting an environmental review of proposed alternative interim disposal sites. As sewage treatment facilities are upgraded and more sludge is produced, ocean dumping will become even more controversial.

ISSUES TO WATCH FOR

As indicated above, airing of proposed amendments to the Federal Water Pollution Control Act has already begun within the Administration. The Water Pollution Control Federation and state environmental administrators have also proposed amendments.[100] The Congress will probably delay formal consideration of any of them until it receives the report of the National Commission on Water Quality.

Municipal Pollution

The municipal grants program is the subject of many proposed amendments. Some of the most important issues are:

- The level of federal funds to be authorized after the current authorization is completely obligated
- Delay of municipal compliance with the act
- Changing of the federal share for municipal treatment facility grants

Table 9

Ocean Dumping in 1968, 1973, and 1974

(In thousands of tons)

Waste type	Atlantic			Gulf of Mexico			Pacific			Total		
	1968	1973	1974	1968	1973	1974	1968	1973	1974	1968	1973	1974
Industrial waste	3,013	3,997	4,344	696	1,408	950	981	—	—	4,690	5,405	5,294
Sewage sludge	4,477	5,429	6,542	—	—	—	—	—	—	4,477	5,429	6,542
Construction and demolition debris	574	1,161	2,290	—	—	—	—	—	—	574	1,161	2,290
Solid waste	—	—	—	—	—	—	26	0.2	0.2	26	0.2	0.2
Explosives	15	—	—	—	—	—	—	—	—	15	—	—
Total	8,079	10,587	13,176	696	1,408	950	1,007	0.2	0.2	9,783	11,995	14,126

Source: Council on Environmental Quality, *Ocean Dumping—A National Policy* (Washington, D.C.: Government Printing Office, 1970); Environmental Protection Agency, unpublished reports, 1973–74.

- Restriction of federal funding to certain types of facilities (e.g., interceptor versus collector sewers)
- Use of federal funds to build excess capacity in anticipation of population growth
- Additional legislative requirements to ensure against adverse direct or indirect environmental impacts
- Reduction in the administrative complexities of the act, including further delegation of authority and responsibility to the states
- Reallocation of federal funding between and within states.

Industrial Pollution

At least some of the many court cases challenging EPA's effluent guidelines should be decided during the coming year. These decisions could have a significant impact on the speed with which the industrial abatement program progresses.

At the same time there will be substantial pressure to relax industrial abatement requirements by amending the FWPCA. However, little is likely to be done in this regard until the Congress has had time for careful review of the National Commission on Water Quality report.

Much of industry's concern results from difficulties in obtaining sufficient investment funds; there will be continued consideration of proposals to ease these financing problems, particularly for smaller businesses. On the other hand, there is increasing concern about the high costs of subsidizing industrial pollution control investment through industrial revenue bonds, and some efforts may be made to cut back this program.[101]

Controlling "Nonpoint" Sources

The FWPCA strictly controls the discharge of pollutants from all point sources. By regulation EPA had excluded some hard-to-manage pollution sources by defining them as nonpoint sources. It had thus exempted discharges from storm sewers and relatively small feedlots, silvicultural activities, and irrigation return flows. In *Natural Resources Defense Council* v. *Train,* the court ruled that this definition of "point source" was contrary to the intent of the Congress.[102] The effect of this finding is to force EPA to issue effluent guidelines for each of these previously excluded sources, defining treatment necessary by 1977 and 1983. Discharge permits will have to be issued for each. Given the existing lag in effluent guideline development and permit issuance, this new authority poses significant administrative problems for the agency. However, from the point of view of water pollution control, it could provide a regulatory basis for approaching the complicated problem of runoff, especially from urban and urbanizing areas.

Toxic Pollutants

A court decision may again raise the issue of toxic pollutants.[103] In May 1974 environmental groups lost a court challenge to EPA's initial proposed list of toxic pollutants and the agency's failure to meet the timetable set by the act.[104] A second suit was filed in April 1975 because the agency still had not published regulations.[105] This case could force EPA to take a much more active role in regulating toxic pollutants.

Sludge Disposal

The problem of what to do with the sludge being generated by both municipal and industrial facilities is growing continuously more serious. Ocean dumping restrictions prevent traditional disposal patterns, while high energy costs and strict air pollution controls make incineration less attractive, and high land prices and continued citizen opposition discourage the use of landfills. EPA has already devoted considerable effort toward improving sludge disposal technologies. But until better solutions are found, the increased amounts of sludge generated by advanced waste water treatment systems will make the disposal problem progressively significant and controversial.

Protecting Aquifers

The Safe Drinking Water Act permits citizens to petition EPA to determine that a particular aquifer is a principal drinking water source. Several such petitions have been received by EPA, which has to decide whether to designate the areas for protection. If EPA does designate such areas, there are likely to be various tests of the law and of the regulatory authority of EPA, especially over federally supported activities regarding aquifer recharge areas.

The problem of sludge disposal is growing continually more serious. Here dewatered sludge is being hauled away to a landfill and for use as fertilizer.

NOISE

BACKGROUND

Before 1972, major federal activities in the field of noise control legislation were limited.[106] By a 1968 amendment to the Federal Aviation Act, FAA was directed to regulate civil aircraft noise, including sonic booms.[107] Federal Aviation Regulations, Part 36 (FAR 36) became effective on December 1, 1969.[108] The regulations, which prescribed substantially reduced noise levels for new types of subsonic aircraft, are still the basis of maximum perceived ground noise levels for subsonic transport aircraft landings and takeoffs.

In 1973 the FAA promulgated regulations prohibiting operations of civil aircraft which would cause sonic booms to reach any part of the United States.[109] In 1971 the first federal occupational noise exposure regulations were promulgated by the Department of Labor under provisions of the Occupational Safety and Health Act of 1970.[110]

The Noise Control Act of 1972 became law in October 1972.[111] Under the act, the Environmental Protection Agency exercises primary regulatory authority for products distributed in commerce. It provided uniform federal regulation of major noise sources, specifically construction equipment, transportation equipment, motors, and electrical equipment.[112]

EPA coordinates the noise control programs of all federal agencies, and when it believes that a proposed standard or regulation fails to protect public health and welfare, EPA may request an agency to report on the advisability of revising the standard or regulation. That agency must then publish its findings and conclusions in the *Federal Register*.[113] A more complex statutory procedure is applicable to FAA regulations, but the thrust is that EPA has a prominent role as advisor to FAA in promulgation of aircraft noise control regulations.[114]

Although states and municipalities retain primary responsibility for noise control, they may not enact laws or regulations that conflict with federal noise emission levels. But they may restrict the use, operation, or movement of any product or combination of products, including trucks, engaged in the construction industry.[115] For motor carriers involved in interstate commerce and for railroads, preemption by federal regulation is total, except that states and political subdivisions may enact identical standards.[116] EPA provides technical assistance for local government development and enforcement of noise standards. To this end training programs have been established and model legislation proposed.

The act does not affect federal preemption with respect to airport noise, and the issue remains governed by prior statute and case law. *Burbank* v. *Lockheed Air Terminal, Inc.* held that a municipality cannot exercise its police power to control noise from a pri-

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vately owned airport within its borders.[117] But it also appears that a state or local agency, as the proprietor of an airport, may deny use of that airport to aircraft on the basis of noise considerations.[118]

Under the Noise Control Act, EPA must develop criteria identifying the effects of noise on public health and welfare and must specify the noise reduction necessary for protection with an adequate margin of safety.[119] EPA's basic "levels" document, which identified noise levels requisite to protection of public health and welfare, was published in March 1974.[120] It concluded that virtually all the population is protected against lifetime hearing loss when annual exposure to noise, averaged on a 24-hour daily level, is less than or equal to 70 A weighted decibels. This is denoted as equivalent level and is expressed as Leq (24) $\leq$ 70 dB. The equivalent level (Leq) for 24 hours, weighted for nighttime noise exposure, is denoted as Ldn, day-night level. Noise levels found requisite to residential outdoor enjoyment and to indoor activities are Ldn $\leq$ 55 dB and Ldn $\leq$ 45 dB, respectively.[121]

Exposure to a particular noise is usually expressed in A weighted decibels (dBA); Leq and Ldn refer to an average of these individual exposures over time. Most hearing losses occur with repeated exposures over long periods. Figures 5 and 6 show familiar noise exposures for single events and day-night average levels.

EVENTS OF THE PAST YEAR

EPA Regulations

On October 29, 1974, EPA published its final regulation for motor carriers of over 10,000 pounds engaged in interstate commerce. Effective October 15, 1975,[122] it reflects "degree of noise achievable through application of the best available technology, taking into account the cost of compliance." [123] The regulation sets a maximum of 86 dBA measured from a 50-foot distance at speeds of 35 miles per hour or less and a 90 dBA level at speeds over 35.[124] A notice of proposed rulemaking was issued for locomotives and railroad cars in July 1974.[125] The proposed maximum, effective 9 months after promulgation, is 96 dBA and 93 dBA, respectively, measured 100 feet away. After 4 years the maximum level for locomotives is to be reduced to 90 dBA.[126] The Department of Transportation will enforce these regulations.

In October 1974 notices of proposed rulemaking were issued for new portable air compressors [127] and new medium- and heavy-duty trucks.[128] Maximum compressor levels of 76 dBA measured 23 feet from the source are to be achieved within 1 year of promulgation.[129] Medium- and heavy-duty truck noise is to be regulated in stages—model years 1977–80 are not to exceed 83 dBA measured at 50 feet, model years 1981–82 are not to exceed 80 dBA, and model years after 1983 are not to exceed 75 dBA.[130]

Figure 5

Sound Levels and Human Response

	Noise level	Response	Hearing effects	Conversational relationships
Carrier deck jet operation	140			
		Painfully loud		
	130	Limit amplified speech		
Jet takeoff (200 feet) Discotheque	120			
Auto horn (3 feet)		Maximum vocal effort		
Riveting machine	110			
Jet takeoff (2,000 feet)				Shouting in ear
Garbage truck	100			
N.Y. subway station		Very annoying		
Heavy truck (50 feet)	90			Shouting at 2 feet
Pneumatic drill (50 feet)				Very loud conversation, 2 feet
Alarm clock	80	Annoying		
Freight train (50 feet)				
Freeway traffic (50 feet)	70	Telephone use difficult	↑ Contribution To Hearing Impairment Begins	Loud conversation, 2 feet
		Intrusive		
Air conditioning unit (20 feet)	60			Loud conversation, 4 feet
Light auto traffic (100 feet)	50	Quiet		Normal conversation, 12 feet
Living room				
Bedroom	40			
Library				
Soft whisper (15 feet)	30	Very quiet		
Broadcasting studio	20			
	10	Just audible		
	0	Threshold of hearing		

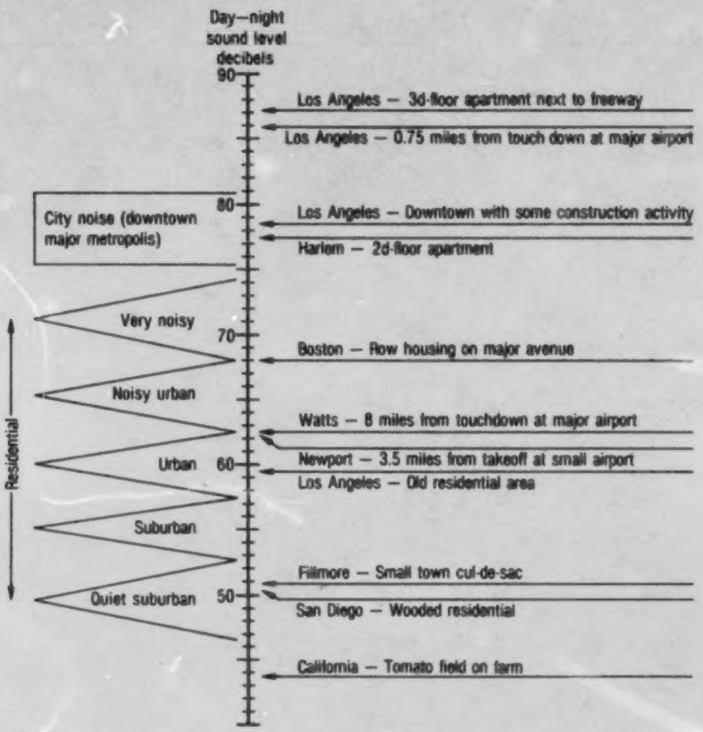
Source: Environmental Protection Agency, *Noise Pollution: Now Hear This* (Washington, D.C.: Government Printing Office, 1974 reprint).

Products identified for future regulation are motorcycles, buses, earthmoving equipment, and special auxiliary equipment on trucks.[131]

EPA has consulted with many other federal agencies in exercising its advisory function. Its first report on federal noise control programs was published in June 1975.[132] This comprehensive report describes the noise abatement activities of all federal agencies and outlines the agencies' progress toward a long-range national noise control program. Notable examples of EPA agency interaction are its relationship with the Department of Transportation in regulating aircraft

Figure 6

Outdoor Sound Levels at Various Locations



Source: Environmental Protection Agency, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (Washington, D.C.: Government Printing Office, 1974), p. 14.

and airport noise and that with the Department of Labor in regulating occupational noise levels.

Aircraft and Airport Noise

There is evidence that the relationship between EPA and the Federal Aviation Administration created by the Noise Control Act has stimulated regulatory activity that will ultimately result in greater protection of public health and welfare from aircraft noise. EPA's proposed noise standards for small propeller-driven airplanes and similar FAA regulations were published in January.[183] EPA's proposed noise abatement minimum altitudes for turbojets in terminal

The effectiveness of motor carrier noise regulations can be monitored by noise-level meters located near highways, here near Phoenix.

areas were also published in January.[134] The proposed regulation would reduce community noise from airplanes by about 9 decibels by keeping planes above 3,000 feet prior to entering their glide slope instead of the presently required altitude of 1,500 feet.[135] Public hearings were held on both proposals in March 1975. After consideration of the evidence FAA will announce its decision.

When the Noise Control Act was passed, FAR 36 was in effect.[136] This FAA noise regulation required that all jet-propelled transport planes not exceed specified noise levels. It exempted some types already in service even though built after the date of the regulation. FAR 36 was amended by the FAA in October 1973 to require all new turbojets and subsonic transport airplanes to comply with its terms.[137] On March 27, 1974, FAA published a proposed rule which would have required airplanes already in service to comply with FAR 36.[138] However, no final regulation was adopted.

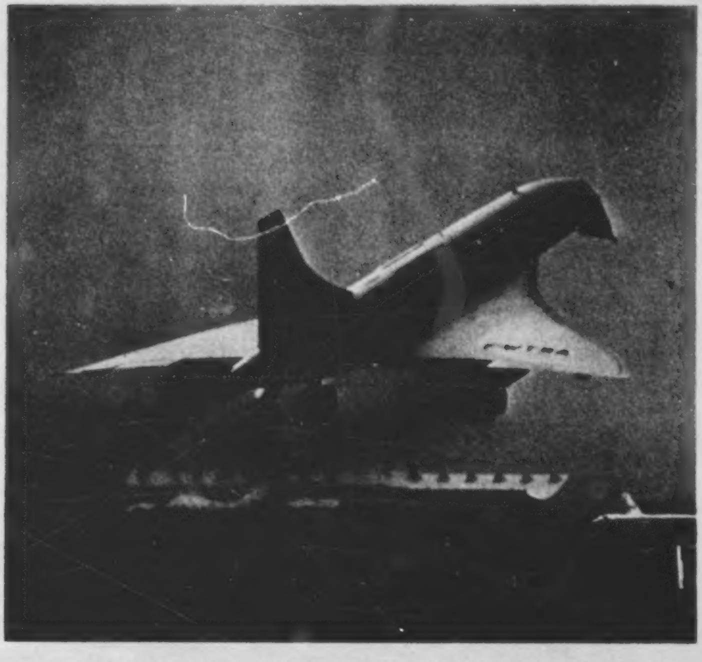
EPA's proposed retrofit regulation was published on February 26, 1975.[139] It would require all existing jet airplanes to comply with FAR 36 by June 30, 1978. The new proposed regulations show EPA and FAA in basic agreement except that the FAA's would not apply to planes with a maximum weight of less than 75,000 pounds, whereas EPA's proposal would require compliance by all jet airplanes, regardless of weight. EPA has also proposed a fleet reporting regulation which would require annual reporting and publication of fleet noise levels.[140]

Public hearings were held in March 1975, but no final regulations had been issued as of mid-1975.

The SST

On February 14, 1975, Air France applied to the FAA for an amendment to its operations specifications to permit a limited number of the Concorde supersonic transport flights to John F. Kennedy Airport, New York, and Dulles Airport, Washington, D.C. On February 19 British Airways made a similar application. The flights would average four per day into JFK and two daily into Dulles. The flights are controversial because of environmental issues.

Neither existing FAA regulations nor proposed EPA regulations submitted to FAA for publication and consideration under the Noise Control Act would prohibit the presently planned fleet of 16 Concordes from flying over the United States at subsonic speeds and landing at U.S. airports.[141]



Proposed flights to the United States by Concordes (SST's) like this one taking off at Dulles International Airport are environmentally controversial.

Concorde advocates point out that it will cut flying time from New York to London from 7 to 3.5 hours and that similar flight time reductions will accompany all long-distance transoceanic flights.[142] They further submit that the first generation SST represents aviation progress and is the precursor to later SST's that will not pose environmental problems.

To opponents of the Concorde, these first flights are a foot in the door—with more noisy, polluting SST's eventually landing in larger numbers at U.S. airports. A large fleet of Concordes flying at stratospheric levels would emit pollutants which, through complex chemical reactions, could reduce the ozone layer and increase the earth's exposure to dangerous ultraviolet rays.[143] Opponents of the Concorde also argue that as subsonic jet aircraft are replaced by quieter versions or are retrofitted with sound-absorbing materials, the Concorde, which cannot be retrofitted, will be perceived as even louder in comparison.

Occupational Noise Standards

Existing Department of Labor regulations for maximum occupational exposure to noise prescribe a maximum exposure of 90 dBA for an 8-hour day, with a halving of the exposure time for each additional 5-decibel increment.[144] That is, a worker may be exposed for 4 hours at 95 dBA or 2 hours at 100 dBA during any given workday.

On August 10, 1972, the National Institute of Occupational Safety and Health (NIOSH), an agency within the Department of Health, Education, and Welfare, submitted its criteria document to the Occupational Safety and Health Administration within the Department of Labor (OSHA). It recommended that the occupational standard be lowered from 90 dBA to 85 dBA with a halving of exposure for each additional 5-decibel increment. Eight hours at 85 dBA converts to 4 hours at 90 dBA and 2 hours at 95 dBA. NIOSH based this recommended level on its finding that significant hearing loss occurs at the 90 dBA level.

OSHA published proposed regulations on October 24, 1974, with a 90-decibel 8-hour limit and a 5-decibel halving rate, recognizing that comparatively more workers would be at lower risk at 85 dBA than at 90 dBA but stating that economic impact and technical feasibility problems, as reflected in the draft environmental impact statement, justified keeping the level at 90 dBA.[145]

Acting under its authority given by the Noise Control Act,[146] EPA recommended that OSHA prescribe an 85-decibel 8-hour limit to become effective in 3 years, with a halving for each 3 decibels. Maximum exposure at 88 decibels would be 4 hours and at 91 decibels 2 hours. This recommendation was made by formal "Request for Review and Report" to OSHA published in the *Federal Register* on December 18, 1974. In the opinion of the Administrator, the proposed standard did not protect the public health and welfare to the extent required and feasible.[147]

EPA's request for review pointed out that the OSHA standard ignored EPA's levels document showing that hearing loss can occur from long exposures to levels greater than an Leq (24) of 70 dBA, that the study upon which OSHA relied showed 85 dBA technically feasible, and that the OSHA standard was based upon studies which measured hearing loss only at lower frequencies when in fact loss first occurs at higher frequencies.[148]

More important, however, EPA submitted that 8.68 million workers were presently exposed to 85–89 dBA and that if EPA's proposed standard were adopted, the number exposed would drop to 560,000 workers. Thus "approximately 8.1 million workers would be prevented from suffering the [hearing loss] resulting from exposures of 85 dBA to 90 dBA." [149]

On March 18, 1975, OSHA published its reply to EPA and took issue with all points raised but agreed that it was technologically feasible to achieve an 85 dBA exposure for workers in 92 percent of jobs.[150] Relying on different studies for data to support its conclusions, OSHA argued that exposure to 90 dBA for any 8-hour day with a 5 dBA tradeoff did not materially impair health or functional capacity.[151]

ISSUES TO WATCH FOR

A draft environmental impact statement filed by OSHA in June 1975 supports maintaining the current 90-dBA 8-hour occupational noise exposure standard. A program of audiometric testing is proposed for workers exposed to 85 dBA or more over an 8-hour period to detect shifts in hearing before significant impairment occurs so that individual employees may be given added protection. Hearings began on June 21, 1975, with EPA, NIOSH, and OSHA as parties. Testimony was presented by these agencies and by university, labor, and industry people. OSHA's final decision was still pending as this report went to print.

Also pending were FAA decisions on retrofitting jet airplanes with sound-absorbing materials and on applications to begin commercial Concorde service in the United States. How soon airport noise is reduced will be governed by the rate of replacement and/or retrofit of existing airplanes. If Concorde flights are approved, the initial impact will raise rather than lower noise levels at affected airports.

SOLID WASTES

BACKGROUND

Projecting future solid waste generation is extremely uncertain under present conditions of rising material and energy prices. It is still too early to judge the extent to which the materials pricing structure has been permanently altered by these developments. Last year's Annual Report described the manner in which rising fuel prices can impact solid waste disposal decisions, but the questions of how much and when are still unanswerable with any degree of accuracy.

Table 10 estimates material recycling from postconsumer wastes for 1973, the most recent year for which data are available. The quantities shown include only materials recovered from *postconsumer* product sources, not materials recycled from preconsumer industrial processing, fabricating, or converting operations or from other postconsumer sources such as demolition or junk auto shredding. This is not meant to minimize problems associated with preconsumer solid waste disposal. However, the most severe problems are associated with toxic and hazardous wastes associated with particular industries and mine tailings and with agricultural residues specific to particular localities. They are beyond the scope of this brief discussion. Also,

Table 10

Postconsumer Residential and Commercial Solid Waste Generation and Resource Recovery, by Type of Material, 1973

(In millions of tons, wet weight)

Material categories	Gross discards	Material recycled[1]		Net waste disposal	
		Quantity	Percent	Quantity	Percent
Paper	53.0	8.7	16.5	44.2	32.8
Glass	13.5	0.3	2.1	13.2	9.9
Metals	12.7	0.2	1.6	12.5	9.3
Ferrous	11.2	0.2	1.4	11.0	8.2
Aluminum	1.0	0.04	4.0	1.0	0.7
Other nonferrous metals	0.4	0.0	0.0	0.4	0.3
Plastics	5.0	0.0	0.0	5.0	3.7
Rubber	2.8	0.2	7.1	2.6	1.9
Leather	1.0	0.0	0.0	1.0	0.7
Textiles	1.9	0.0	0.0	1.9	1.4
Wood	4.9	0.0	0.0	4.9	3.6
Total nonfood products	94.8	9.4	9.9	85.4	63.4
Food waste	22.4	0.0	0.0	22.4	16.6
Yard waste	25.0	0.0	0.0	25.0	18.5
Miscellaneous inorganic waste	1.9	0.0	0.0	1.9	1.4
Total waste	144.0	9.4	6.5	134.8	100.0

[1] Resource recovery in 1973 included only material recycling.

Source: U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Resource Recovery Division, *Third Report to Congress: Resource Recovery and Waste Reduction* (Washington, D.C.: Government Printing Office, 1975), p. 10.

many industrial wastes are high-quality, homogeneous material conveniently located for reuse at the factory. For the most part, these materials—for example, metal scraps from milling operations and wood chips from paper mills—are recovered.

Although more paper is recycled than any other material, the unrecovered paper component still represents nearly one-third of total net wastes. Paper is clearly pivotal in the movement toward progressive solid waste management. There is more of it than anything else and it is one of the fastest growing waste materials.

In contrast to paper, only a very small portion of postconsumer metal wastes is recycled—1.4 percent of postconsumer steel, 4 percent of aluminum, and a negligible amount of all other metals. These figures are deceptive because significant amounts of many waste metals, particularly the high-valued nonferrous metals like copper, never reach the postconsumer waste stage because they are actively scavenged by dealers in highly developed scrap markets. Nevertheless, millions of tons of potentially valuable metals are discarded each year.

According to recent EPA projections, total wastes are expected to increase significantly by 1990 (see Table 11). This rise is partially offset by the projected growth of resource recovery—both by recycling and by using waste as a fuel. EPA's estimates assume that a significant number of large-scale waste processing installations will be constructed over the next 10–15 years.

Table 11

Baseline Postconsumer Solid Waste Generation Projections, 1971–90

	Estimated		Projected		
	1971	1973	1980	1985	1990
Total gross discards					
Millions of tons per year	133	144	175	201	225
Pounds per person per day	3.52	3.75	4.28	4.67	5.00
Less resource recovery					
Millions of tons per year	8	9	19	35	58
Pounds per person per day	0.21	0.23	0.46	0.81	1.29
Equals net waste disposal					
Millions of tons per year	125	135	156	166	167
Pounds per person per day	3.31	3.52	3.81	3.86	3.71

Source: U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Resource Recovery Division, *Third Report to Congress: Resource Recovery and Waste Reduction* (Washington, D.C.: Government Printing Office, 1975), p. 10. Projections for 1980 to 1990 are based in part on contract work by Midwest Research Institute.

EVENTS OF THE PAST YEAR

Resource Recovery

The past year brought recession and with it dramatic changes to scrap material markets, particularly to the wastepaper market. Demand for wastepaper was very strong in 1973. Shortages developed, prices rose, and some observers interpreted the market as signaling the beginning of a long-term structural shift to secondary materials.

In March 1974, however, the wastepaper market began a long slump. Prices plummeted from $60 to $5 per ton, and sometimes a buyer could not be found at any price. The recycling boom of the early 1970's appeared to be over and many volunteer recycling centers went out of business. Some municipal collection systems were discontinued. Others sent the collected paper on to landfills.[152]

This experience suggests no real change in the long-run pattern of the demand for paper fiber. Wastepaper is still a marginal source of supply—in demand only when virgin fiber is scarce and the first to go when final product demand diminishes. In the long run, increased recycling will depend upon a commitment by the major firms in the paper industry to use wastepaper day to day, rather than only when virgin fiber is unavailable. For them to do so, a fundamental shift in the economics of recycling is necessary.

Several economic factors now favor virgin production. One is the fact that virgin timber profits are treated as capital gains for tax purposes, an advantage that is not available to wastepaper. Another is the practice of assessing solid waste management costs against municipalities and their general tax funds rather than against those who generate the wastes in proportion to volume. This favors the wastemaker and discourages recycling of paper and other materials.

Market fluctuations, on the other hand, were not as pronounced for most other scrap materials, including glass and ferrous and nonferrous materials. For example, although the price of scrap steel fell precipitously from $102 per ton in November 1974 to below $80 the following January, demand picked up again and prices appear headed back to higher levels. In contrast to the paper industry, steel manufacturers have been investing in production facilities that thrive on significant scrap inputs. Electric arc furnaces that use 100 percent scrap (as opposed to 30 percent for basic oxygen furnaces) now compose 23 percent of our steelmaking capacity, up from 18 percent 10 years ago.[153]

Developments in technology combined with environmental and economic pressures described above continue to encourage initiatives at the state level. As of the end of 1974, 11 states had grant or loan programs for construction of resource recovery systems by municipalities, 12 were involved in planning statewide systems or regulating resource recovery activities through guidelines or conformance re-

Warehouses across the country were filled with wastepaper as the recycling market continued in a slump through 1975.

quirements, and 6 had authority to create agencies to operate resource recovery facilities. They are shown on Table 12.

Connecticut is nearest to a state-operated system. As a result of the comprehensive plan developed by the Connecticut Department of Environmental Protection, the Legislature created the Connecticut Resources Recovery Authority.[154] The plan sets a 1985 date for completion of 10 facilities that will process 84 percent of the state's waste. These are energy recovery facilities that will principally prepare municipal wastes for use as fuel in utility boilers, collecting the unburnable residue for possible recycling.[155]

Nationwide, 6 municipal resource recovery systems are currently operational, another 6 are under construction or are just beginning, and 20 communities are actively preparing to install resource recovery systems.[156] Of this number, only a very few systems are centered strictly on materials recovery, the commonly envisioned recycling plant. As a result of soaring energy prices, most concentrate on energy recovery, either by producing steam for offsite use, by pyrolysis to produce oil and gas, or by feeding the waste directly to utility boilers, as Connecticut does.

In the short run, the past year was a major setback for recycling and recovery, but the prospects for long-run progress are promising in view of the basic economic pressures associated with the costs of virgin materials, energy, and land. Further, improved recovery technology will continue to provide an attractive alternative to traditional disposal methods.

Source Reduction

Source or waste reduction means preventing waste at its source by either physically redesigning products or otherwise changing con-

Table 12

State Initiatives and Community Resource Recovery Projects, March 1975

State	Grants or loans	Planning or regulation	Operating authority	Community recovery systems[1]
California	×	×		1
Connecticut		×	×	3
Delaware				1
Florida	×	×	×	1
Hawaii		×		
Illinois	×			1
Iowa				1
Louisiana				1
Maryland	×			1
Massachusetts		×		5
Michigan	×	×	×	
Minnesota	×	×		1
Missouri				2
New York	×	×		5
Ohio	×		×	3
Oregon				1
Pennsylvania	×	×		1
Rhode Island		×	×	
Tennessee	×			2
Vermont		×		
Washington	×			
West Virginia				1
Wisconsin		×	×	1
Totals	11	12	6	32

[1] All stages, from study through operating.

Source: Richard E. Hopper, *A Nationwide Survey of Resource Recovery Activities*, EPA/530/SW 142 (Washington, D.C.: Government Printing Office, 1975), pp. 2–3.

sumption and waste generation patterns. Less solid waste will be generated by reducing the amount of material contained in products, increasing the lifetime of products, substituting reusable for single-use products, and using a product item more than once.

Industry Status Recent economic conditions have provided considerable incentive for source reduction initiatives by industry. Since 1972, wholesale prices increased from 40 to 60 percent for aluminum, steel, and petrochemicals. Crude oil prices alone have doubled in 3 years.[157] With uncertainty of supplies for many materials, these price rises have caused many industries to reconsider product design and selection. The Campbell Soup Company, for example, has begun to market a new type of tin-plated can. The new can uses an estimated 30 percent less material, resulting in a direct cost savings of around 36 percent.[158] Another example is the St. Regis Paper Company, which has suggested many new package designs to reduce paperboard use, including top-loading instead of end-loading containers, single die-cut containers instead of containers with multiple interior components, and standardized container sizes.[159]

Legislation banning or taxing nonreturnable beverage containers has been the most popular type of source reduction proposal.

Industry will continue to redesign products if shortages and price increases continue. It is significant that the need to consider resource use is now a high-priority item in the manufacture of a product. As this direction is established, the impact upon resource use, environmental pollution, and waste generation will certainly be positive.

Returnable Containers Legislation banning or taxing nonreturnable beverage containers has been the most popular type of source reduction proposal. Although several bills have been introduced in the U.S. Congress, more activity has taken place at the state and local levels. Legislation has been introduced in 50 state Legislatures and numerous county and city councils since 1971. As of mid-1975, three states, Oregon, Vermont, and South Dakota, had laws restricting beer and soft drink containers,[160] and one, Minnesota, had a law affecting all major types of packaging wastes.[161] Ordinances affecting beverage containers have been passed in such localities as Oberlin, Ohio, Loudoun County, Virginia, and Bowie, Maryland, although implementation has been slow due to legal challenges.[162]

A mandatory deposit law has been in effect in Oregon since October 1, 1972. A minimum 2-cent refund for beer, malt beverage, and carbonated soft drink containers certified for reuse by more than one manufacturer and a 5-cent refund for all other beverage containers are required. In addition, the sale of fliptop and pulltab beverage containers are outlawed.[163]

A comprehensive 1975 report on the Oregon law concluded that:

- Beverage container litter has been decreased by an estimated 66 percent

- Beer and soft drink sales have neither fallen below the level of the year prior to enactment nor risen as in previous years
- Beer and soft drink prices are lower on the average than prior to the law
- job losses have occurred in the container manufacturing and canning industries
- Jobs have been created in the brewing, soft drink, and retail sectors of the economy.[144]

Experience with the Oregon law, however, has in no way diminished intense labor and industry opposition to other similar bills. Both parties stress the costs of such measures in terms of economic disruption and job losses. Opposition has been particularly strong during the recent recession, with its accompanying high unemployment levels. The force of this opposition, as well as the historic tendency to class solid wastes as a state and local matter, has resulted in inaction on national mandatory deposit bills.

ISSUES TO WATCH FOR

Even given the generally optimistic estimates of resource recovery shown in Table 11, we will still have to dispose of about 23 percent more postconsumer wastes in 1990 than we now do. By then, if current waste disposal practices continue, many municipalities will have exhausted their capacity to deal with solid waste and new disposal arrangements will be necessary.

It seems inevitable that large municipalities will be looking to other jurisdictions for landfill sites. So far the few cities that have tried to persuade other communities to become the depositories of their

This pyrolysis plant being built in Baltimore will convert municipal solid wastes into gas, ferrous metals, and "glassy aggregate."

refuse have had limited success. Mounting pressures may eventually require states to enact enabling legislation of some type and to establish regional or even state solid waste disposal systems.

Incentives for Recycling

As a provision of its energy tax bill, the House Ways and Means Committee in June 1975 reported out a tax credit for use of certain recycled materials based on sales value.[165] The tax credits were for new investment in recovery facilities. Although the measure was ultimately defeated, it is a good example of the type of recycling incentive that has often been advocated during the past few years.

Other proposals to stimulate recycling and conserve energy have advocated guaranteed loans for recycling facilities, price supports for scrap materials, ending the depletion allowances for virgin materials, and eliminating the bias against recycled materials in rail freight rates.

Recycling incentives will continue to be debated as efforts to cut energy waste and to ameliorate growing municipal solid waste problems continue in coming years. So far proponents have found it difficult to make a case for the benefits claimed for incentives for more recycling. Opponents believe that incentives are unnecessary and will result in windfalls to existing operations.

Source Reduction

One comprehensive proposal would tax products on the basis of their contribution to national solid waste disposal costs. The theory is that because it is administratively difficult to charge consumers equitably for the waste that they generate, the cost should be borne directly by the consumer products. Charging relative product costs to the consumer would lead to change in consumption patterns and would induce manufacturers to produce less wasteful products.

HAZARDOUS POLLUTANTS

BACKGROUND

Current government authorities covering hazardous pollutants are piecemeal and incomplete. Since 1971 the Administration has supported enactment of a comprehensive Toxic Substances Control Act which would provide authority to regulate any chemical. In addition, it would allow EPA to require selective testing of new chemicals prior to marketing. Under the present patchwork legislation, many chemicals enter the marketplace and gain economic importance before their nature is well-understood. If they are later found to be toxic and must be restricted, some economic disruption inevitably follows.

The earliest federal law governing toxic chemicals was a pesticide control law in 1910;[166] it has since been replaced by broader legislation.[167] The Atomic Energy Act of 1954, still in effect, authorized control of radioactive materials to protect health, life, and property.[168] EPA sets environmental standards under this law, and the two new nuclear agencies, the Nuclear Regulatory Commission and the Energy Research and Development Administration, administer the protective rules.

The environmental awakening of the early 1970's produced several more laws dealing with control of toxic substances. Under the Clean Air Act of 1970, EPA may set upper limits for stationary source air pollutants that tend to increase death or serious disease.[169] Specific standards have been set for asbestos, beryllium, and mercury.[170]

Water quality receives a measure of protection from several laws. The Ocean Dumping Act of 1972 uses a permit system to prohibit or strictly limit ocean dumping of wastes that would harm human health or welfare, or threaten the marine environment.[171]

The Federal Water Pollution Control Act (section 307) authorizes control of toxic pollutants in regular outflows from industry or city waste water treatment plants; it directs EPA to set limiting standards for these pollutants or possibly to prohibit them entirely.[172] EPA has proposed 12 chemicals for regulation; included are a group of pesticides—aldrin-dieldrin, DDT and its derivatives DDE and DDD, endrin, and toxaphene; the metals cadmium and mercury; cyanide; and benzidine and PCB's, two synthetic organics which are widely used in industry. Under section 311 EPA has the power to regulate spilling and dumping of hazardous pollutants in navigable inland waters. EPA has taken the initial steps toward listing 373 substances as dangerous to public health and welfare.[173] No final regulations have yet been issued under these two sections.

The Safe Drinking Water Act, signed into law on December 16, 1974, is the latest addition to the list of laws affecting toxic substance control.[174] Under this authority the Administration is empowered to set drinking water standards for toxic substances.

The following section concentrates on three aspects of hazardous pollution—pesticides, occupational health, and a miscellany of toxic substances. For each of these groups federal authority is at a different stage.

Pesticide control, which dates back to 1910, is well-established. More recent laws, especially the Federal Environmental Pesticide Control Act of 1972, have strengthened federal authority, which now extends beyond labeling of pesticides to control of their use.[175]

Federal regulation of on-the-job pollutants that may threaten workers' health is at an intermediate stage. It rests upon implementation of the Occupational Safety and Health Act of 1970.[176] Standards under this act are being developed.

Control of many other toxic substances is less satisfactory. For the fifth year, we call attention in our Annual Report to the need for a toxic substances law that would authorize the government to control production, distribution, and use of these substances; require manufacturers to disclose scientific information about them; and provide for the selective testing of new chemicals before they are marketed and of older ones that are already in use. Bills with these authorities have passed both the Senate and the House at various times, and legislation was pending in the Congress in mid-1975,[177] but as yet there is no law.

EVENTS OF THE PAST YEAR

Pesticides

Evolution of the Law The Federal Environmental Pesticide Control Act of 1972 (FEPCA) supersedes the old 1947 law, the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 (FIFRA),[178] and is being implemented over a 4-year period. The new law forbids anyone (including the federal government) to use a pesticide contrary to label instructions, gives EPA authority to "restrict" a pesticide so that only people trained in approved programs may apply them, and extends control to products sold intrastate.

Regulations published in June 1975 for section 3 of FEPCA establish a screening procedure.[179] If a new pesticide is chemically suspect of causing cancer, birth defects, or mutations, it must undergo thorough testing before it is declared safe for use. Suspect pesticides that are already registered (approved for use in accordance with instructions on the label) retain their registration provisionally, pending tests.

The regulations also require the development of data to support field reentry standards to prevent poisoning by pesticide residues. These standards set a minimum time after spraying when farm workers may not enter fields.

Regulatory Action On October 1, 1974, while cancellation proceedings begun over 3 years earlier were still in progress, EPA suspended registration of the pesticides aldrin-dieldrin on grounds that new evidence showed an imminent hazard.[180] This decision was based, in part, upon the fact that animal experiments showed these pesticides to be carcinogenic.

The suspension was upheld by the District of Columbia Court of Appeals in April 1975 in a significant decision which held that the burden to prove safety rests on the registrant.[181] Another important feature of the decision was its acceptance of animal test results as an indication of cancer risk to human beings.

In November 1974 EPA began proceedings to cancel registration of heptachlor and chlordane. Here too EPA took action before the cancellation hearings were completed, when in July 1975 the Administrator issued a notice of intent to suspend uses of these pesticides immediately. Again the basis for the suspension was animal experiments which showed that the pesticide causes cancer.[182]

Other EPA hearings that may lead to cancellation of pesticides concern mirex, which is used in Southern states to control fire ants, and phenyl mercury compounds, which are mainly used to treat seeds for plant disease prevention.

DDT Most uses of DDT have been banned since 1972. Since then EPA has received many applications for special exemptions from the restrictions but has granted a major exception only once. In 1974 the U.S. Forest Service was permitted to use DDT to control tussock moths in the forests of the northwest.[183]

The state of Louisiana applied in January 1975 for permission to use 2.25 million pounds of DDT against the tobacco budworm, a cotton pest. EPA denied the application in March, chiefly on grounds that the case added no substantial new evidence to the material considered in the original decision.[184]

Occupational Health

Illness and death from exposure to toxic pollutants in the workplace has a long, important history. It is here that the hazardous nature of many substances is often first revealed and is usually most severe.

The Occupational Safety and Health Act of 1970 authorized the Labor Department to establish standards for hazardous pollutants on the job, to provide training programs, and to set up an injury and illness reporting system.[185] These are the duties of OSHA (Occupational Safety and Health Administration). NIOSH (National Institute for Occupational Safety and Health) conducts research and recommends standards to OSHA.

The act provides for three kinds of standards. National consensus standards were adopted from a list developed and agreed upon by the American Conference of Governmental and Industrial Hygienists, a group of industrial and government scientists. They recommended maximum average 8-hour limits for worker exposure to chemicals in the air (threshold limit value, or TLV). Permanent standards issued at the discretion of the Secretary of Labor are broader. They generally also cover work practices, monitoring, and medical surveillance. Temporary emergency standards, effective for 6 months only, may be used for interim protection while OSHA develops permanent standards.

Some 400 chemicals are covered by consensus standards. In 1974, OSHA and NIOSH began a joint effort to complete these threshold limit value standards in the form of permanent standards. This "standards completion process" is not considering changes in threshold limit values. Rather, it involves supplementing the TLV with requirements to monitor air concentrations of pollutants, to conduct medical surveillance at regular intervals, and to report important results and incidents. Chemical compounds are being considered in groups, with the first set of requirements proposed for 6 ketones. Standards for other groups are expected to follow shortly.

Three sets of permanent standards have been promulgated under the Occupational Safety and Health Act: for asbestos,[186] for vinyl chloride,[187] and for a group of 14 carcinogens.[188] All the standards followed the imposition of temporary emergency standards. One temporary emergency standard for reentry of farmworkers into fields sprayed with pesticides lapsed in 1973; field reentry is now covered by EPA under the pesticide law of 1972.[189]

A chemical workers union challenge against all 14 carcinogen standards on the grounds that they were too lax was denied by the Third Circuit Court of Appeals in Philadelphia. An industry challenge against four of the standards claiming that the chemicals are not in fact carcinogens failed in three cases. In its decision in December 1974 the circuit court set aside the remaining standard on procedural grounds.[190] OSHA has since held new hearings and reproposed the same standard;[191] a renewed promulgation of this standard is expected soon.

During the past year OSHA has proposed permanent standards, based in part on NIOSH criteria documents, for arsenic,[192] coke oven emissions,[193] and noise[194] (see the noise section of this chapter).

Arsenic Arsenic, universally known as an acute poison, is also suspect as a cause of lung, skin, and lymphatic cancers in workmen exposed to it.[195] The present threshold limit value for airborne arsenic is 0.5 milligrams per cubic meter of air for an 8-hour average.[196]

Under the OSHA proposed standards completion process, monitoring the concentration of air pollutants in the workplace will be required for approximately 400 chemicals. Here an industrial hygienist is taking samples in the breathing zone of a paint worker.

OSHA's proposed permanent standard (published in January 1975) would lower the allowable level to a range of 0.004–0.002 milligrams per cubic meter of air for an 8-hour workday, with a maximum exposure of 0.01 for any 15-minute period.[197] The standard also requires protective equipment and medical surveillance for early diagnosis of arsenic-related disease. It provides for the use of respirators when air concentrations rise above the permissible level.

Coke Oven Emissions The products of burning coal have long been known to cause cancer. In particular, coke oven workers suffer a two- or threefold excess of lung, skin, and urinary system cancer.[198]

Coke ovens are used principally in the steel industry to convert coal to coke, which is subsequently mixed with iron in steelmaking. The consensus standard for coke ovens allows 0.2 milligrams of coal tar pitch volatiles per cubic meter of air.[199]

In July 1975 OSHA published proposed new rules for worker exposure to coke oven fumes.[200] Which of the substances in coke oven fumes causes cancer is largely unknown; the proposed standard therefore requires measurements of particulate matter only. The limit for worker exposure to respirable particulates in an 8-hour workday would be an average of 0.3 milligrams per cubic meter of air. Benzo(a)pyrene is a known carcinogen in coke oven fumes; monitoring twice yearly for recordkeeping purposes would be required. The proposed standard also provides for protective clothing and medical surveillance. Its requirements could be met immediately through engineering and work practice controls. When it is not met, respirators would have to be used.

Vinyl Chloride A permanent standard for vinyl chloride took effect in April 1975, little more than a year after the discovery of a

Worker exposure to coke oven emissions in plants such as this one in Pittsburgh would be limited by proposed OSHA standards.

score of deaths from a rare liver cancer among workers exposed to the compound. In January 1974 NIOSH announced the deaths of four workers from angiosarcoma. Many more fatal cases have been identified. Vinyl chloride gas is produced at 15 locations in the United States and is used at 37 or more plants in the manufacture of polyvinyl chloride plastic—the most commonly used clear plastic.[201]

By April 1974 OSHA issued a temporary emergency standard of 50 parts per million. The next month a permanent standard of 1 ppm was proposed. The final standard, promulgated in October 1974, requires respirators in any workplace with more than 1 ppm of vinyl chloride gas. Until April 1976 workers may elect not to use respirators, so long as air concentration of the compound is not above 25 parts per million. The standard also requires monitoring, medical surveillance, and recordkeeping.

The standard became effective after the Second Circuit Court of Appeals struck down an industry challenge, which claimed that there was no proof to justify a limit so strict as 1 part per million. The court, noting the lives lost to this toxic chemical, upheld OSHA's decision to reduce exposure to the lowest possible level.[202]

Other Hazardous Pollutants

Fluorocarbons Scientific evidence first published in June 1974 suggested that fluorocarbon releases may eventually affect the protective ozone layer in the stratosphere and thereby allow increased harmful solar radiation to reach the surface of the earth. Fluorocarbons are the propellants in about half of all aerosol cans and are the principal fluids used in refrigerators and air conditioner coils.

In January 1975 the Council and the Federal Council for Science and Technology formed an ad hoc interagency task force on Inadvertent Modification of the Stratosphere to assess the situation and to develop an appropriate federal response. The IMOS report, *Fluorocarbons and the Environment,* issued in June, found that there is "legitimate cause for concern." The findings and conclusions of the task force are summarized in Chapter 7.

The National Academy of Sciences is now conducting a comprehensive assessment of man's impact upon the stratosphere and will report its findings in April 1976. Meanwhile, research sponsored by various federal agencies and industry is proceeding rapidly. The State Department is taking the lead for the United States in developing a coordinated international approach to this global problem.

Lead Lead is one of the most significant environmental threats to health. Once lead enters the body, it can cause anemia, severe intestinal cramps, and at higher doses, permanent nerve damage and death.

The most important way that lead enters the human body is through eating it. Young children with pica (the abnormal ingestion of nonfoods) may contract acute lead poisoning from paint and dirt that contain lead. The second most important source of lead in the body is airborne lead. In areas where there are no industries that produce or use lead, 90 percent of airborne lead comes from auto tailpipes.

Lead in Gasoline An EPA regulation under the Clean Air Act requiring phased reduction of lead in gasoline was vacated in a December 20, 1974, court decision.[203] The District of Columbia Circuit Court of Appeals ruled in a suit brought by the Ethyl Corporation that the requirement to reduce lead to 0.5 grams per gallon by 1979 was without scientific basis.

EPA's motion for a rehearing by the entire court was granted, and new hearings were held in May 1975. All nine judges will participate in the new decision.

Lead in Paint Lead levels in paint are governed by a special federal law, the Lead-Based Paint Poisoning Prevention Act.[204] The act states that by the end of 1975 lead in paint for household interiors must not exceed 0.06 percent by weight; the previous permissible lead level was 0.5 percent. The act has an escape clause, however. The Chairman of the Consumer Product Safety Commission (CPSC) could forestall the change by determining that some other level (not to exceed 0.5 percent) was safe and by presenting a written report to this effect to the Congress.

Chairman Richard Simpson reported to the Congress in January that a 0.5 percent lead level was safe.[205] In March the Consumers Union of the United States filed a petition with the CPSC requesting reduction to the 0.06 percent level. The decision will be made by the full five-member commission. The Consumers Union also filed suit to reverse Chairman Simpson's determination, contending that 0.5 percent was not demonstrated to be safe as required. The case is now pending before the Federal District Court of the District of Columbia.

The same act empowered the Department of Housing and Urban Development to regulate lead paint already on the walls of HUD-financed or HUD-owned housing. In June HUD proposed rules to force the removal of flaking lead paint from dwellings where children have been found to be poisoned.[206] The standards are not yet final. In some areas of the country, attempts are made to locate lead hazards before poisoning occurs. In such cases, the threat may be removed by stripping off the old paint.

Drinking Water Since the turn of the century, chlorination of drinking water has been widely used to stamp out typhoid fever, dysentery, cholera, and other diseases arising from bacterial contamination of drinking water. In more recent years thousands of new chemicals have come into common use. Many of them permeate our drinking water sources through industrial discharges into waterways, runoff from farmland, city storm sewer runoff, or treated sewage discharges. It was recently discovered that some of these chemicals may react with chlorine in drinking water to produce chloroform and other toxic chlorinated hydrocarbons.

In June HUD proposed regulations to force the removal of flaking lead paint in housing where children have been found to be poisoned.

In the summer of 1974 articles in the press about possible chemical contamination of drinking water in New Orleans and other cities caused some alarm. EPA then began a survey of water supplies in 80 cities. Preliminary results, published in April 1975, confirmed widespread low-level contamination in the 79 cities surveyed so far. Among the contaminants were chloroform, bromodichloromethane, dibromochloromethane, bromoform, carbon tetrachloride, and 1,2-dichloroethane.[207] Some of these compounds are believed to be carcinogenic. Studies are continuing, and when complete, they will become part of the information base for setting new standards under the Safe Drinking Water Act.

Asbestos Asbestos is a known human carcinogen. When inhaled, it causes lung cancer and otherwise rare cancers of the chest and stomach cavity linings—pleural and peritoneal mesothelioma. Occupational exposure to asbestos has provided unmistakable evidence of its dangers. Gastrointestinal cancer is three times as common among asbestos workers as in the general population. About one-half of asbestos workers die of cancer, compared with one person in five or six in general.[208]

Asbestos-like fibers were discovered in the drinking water of Duluth, Minnesota, and nearby communities on Lake Superior's north shore in 1973. The source was traced to the Reserve Mining Company's discharge of 67,000 tons of taconite (low-grade iron ore) tailings into the lake every day.

EPA, the states of Wisconsin, Michigan, and Minnesota, and several environmental organizations filed suit in the federal district court in an effort to end Reserve's discharge. Defendants in the suit included Reserve's parent companies, other businesses, and several north shore communities. They argued that there was no scientific proof that ingesting asbestos in drinking water was harmful to health but that economic harm from shutting down the mining company was a certainty. The plaintiffs contended that because asbestos is known to cause cancer (including gastrointestinal cancer) when inhaled, it poses a cancer risk when ingested. By the time absolute scientific proof is available, the harm may be irreversible. In April 1974, the district court judge directed Reserve to halt its discharge immediately on public health grounds.

After several temporary stays of the lower court order, the Eighth Circuit Court of Appeals ruled in March 1975 that there is no imminent danger to the residents of the north shore but that a potential health hazard exists.[209]

In the meantime, the city of Duluth, with federal support, had taken steps toward installing a filtration system to remove the fibers from the drinking water. The appellate court ruled that under these circumstances, Reserve could continue discharging until the company and the state agreed upon an onland disposal site. The company would then have a further reasonable time to convert to onland disposal. If no site is agreed upon, the company must close within 1 year thereafter.

ISSUES TO WATCH FOR

Toxic Substances Legislation

There are major gaps in federal authorities to control toxic substances. The government may prescribe safety testing for foods, drugs, cosmetics, pesticides, and fuel additives—but not for hundreds of other chemicals in widespread use. Thus, a chemical like vinyl chloride can do grave harm before its dangerous nature is detected.

There are also large gaps in access to information. In many cases, the government has no power to obtain industry toxicity studies or other privately held information that might help to identify or evaluate problems.

Finally, many chemicals that present major environmental problems escape government regulation almost entirely. There are no statutes under which PCB's may be restricted to uses that do not threaten the environment. Government must rely mainly on voluntary industry cooperation to control their use. (For a description of the status of the PCB problem, see Chapter 3.) Similarly, should it prove necessary to regulate fluorocarbons, there are no federal laws covering commercial and industrial use.

There is a clear need for legislation that would control the introduction of toxic substances into the environment without requiring unnecessary testing equivalent to a chemical registration system prior to commercial use.

The Burden of Proof

In several of the cases reported above, burden of proof was an important element. In the vinyl chloride and aldrin-dieldrin cases, the courts accepted arguments that serious danger had been demonstrated (by the liver cancer deaths in one case and by animal experiments in the other). So long as EPA's standards were not arbitrary or capricious, the courts did not require clinical proof that public health would suffer if the standards were violated. The burden of proving safety in effect rested on the manufacturer.

In the pending rehearing of the lead case, the issue is whether EPA's standard must be justified with definitive clinical, laboratory, or epidemiological proof that airborne lead above the proposed limit is measurably a danger to public health.

Certain proof of harm is very difficult in public health cases when people are exposed to low levels of toxic substances. Latency periods are long, people move, and many exposures remain unmeasured. These difficulties combine to obscure or delay clearcut results. Meanwhile, serious harm may have been done.

The issue of burden of proof has received attention in the present Congress. Bills have been introduced in both houses to place the burden of proof in public health cases more firmly on the manufacturer.[210] The plaintiff would be required to show evidence of a risk to public health, but the ultimate burden of proving inconsequential risk in comparison with benefits would rest upon the producer.

Organochlorine Compounds

Relatively few chemicals have had to be regulated because of environmental or health hazards. A very significant proportion of those regulated chemicals are organochlorine compounds, including DDT, aldrin-dieldrin, heptachlor-chlordane, hexachlorophene, and vinyl chloride. Other organochlorines, including nearly all pesticides of this class, are currently under scrutiny. Among these are PCB's, mirex, trichloroethylene, hexachlorobenzene, carbon tetrachloride, and chloroform, to name a few. Chlorination of drinking water supplies and industrial effluents has come under question because the process apparently forms cancer-causing organochlorines.

Thus, it appears that organochlorine compounds as a class are becoming suspect of causing a significant share of ecological and health problems resulting from chemicals in the environment.

ENERGY

Past reports of the Council on Environmental Quality have dwelt on energy issues. The reason for this emphasis is clear—the production and consumption of energy probably influence environmental quality more than any other activities of our society. Today's decisions regarding energy policy will have significant, although often uncertain, impacts upon the environment for years to come. Thus it remains particularly important to understand the events leading to the current energy situation, the issues being debated, and those that will probably arise.

BACKGROUND

The roots of U.S. energy troubles may be traced to the gap between energy consumption and domestic production that has been filled primarily by imported oil. In just over 20 years the United States reversed its role as a net exporter of energy. We now import 15 percent of our total energy and 35 percent of our petroleum.[1]

What has caused this turnabout? While U.S. population has grown by more than one-third since 1950, total energy use doubled. Energy consumption grew at an average annual rate of about 3.5 percent from 1950 to 1965 and then accelerated to a 4.5 percent rate until the 1973 oil embargo. In contrast, domestic production grew at an annual rate of only 3 percent between 1950 and 1970 but has shown little or no growth since then.[2]

This slowdown is particularly dramatic for petroleum. Despite the protection offered by import quotas during the 1960's, the nation's historically strong position with respect to domestic supplies deteriorated. Exploration declined and major new oil finds were limited to a few offshore areas and the North Slope of Alaska. At the same time, production of many older U.S. fields began to peak out. New wells were primarily replacements for the older wells rather than suppliers to meet growth.

Imports began to serve our national growth. Oil imports tripled from 1960 to 1973, when they exceeded 35 percent of domestic consumption. Much of the increase came from Middle East and North African sources. In 1973 imports from these sources exceeded 2 million barrels per day.[3]

The natural gas situation, although not so well-recognized as that of petroleum, has become equally important. Between 1950 and 1970, natural gas provided more than half the growth in total energy consumption. Homes and factories turned to natural gas because of its low cost, which was maintained through government regulation, its clean-burning and handling characteristics, and its general convenience.

Low prices, however, worked to discourage exploration for new

Natural gas from the Gulf of Mexico is processed at an onshore plant in southern Louisiana prior to delivery.

supplies while encouraging greater use. By the early 1970's natural gas was in short supply. Service interruption, particularly to "interruptible" industrial customers, was common. In many areas new customers were simply turned away.

While oil and gas consumption was expanding rapidly, markets for coal, once the predominant fuel, were dwindling. Shortly after World War II, railroads shifted from coal-fired steam locomotives to diesel engines. At the same time, residential and commercial coal furnaces were scrapped in favor of oil, gas, and electricity. These changes led to a 36 percent decline in coal output between 1947 and 1962,[4] a blow from which the industry is only now beginning to recover. More recently, rising labor costs combined with stricter mine safety requirements and air pollution standards that discourage the use of coal cut further into coal demand.

Also adding to energy problems was the slow progress of nuclear power. Hailed as an infinite source of cheap energy during the 1950's, nuclear power failed to reach the commercial significance that had been predicted. The industry is troubled by public antipathy on the one hand and technical difficulties on the other. Equipment delivery delays, technical reliability problems, and sagging labor productivity have all contributed to delays in powerplant construction. A few plants have been delayed on the grounds of environmental quality and human safety as well. The economics of nuclear power, once highly promising, have become less certain as the costs of generating plants and adjunct fuel facilities continue to rise. More recently, financial problems affecting the entire utility industry have also slowed progress, forcing cancellation of many plants.

The energy problems that had been building for decades did not become a matter of national urgency, however, until late in 1973.

Then the October war between Israel and the Arab states of Egypt and Syria suddenly politicized U.S. imports of crude oil from the Persian Gulf and North Africa. Demanding withdrawal of U.S. military support for Israel, the Arab states cut off shipments to the United States. World oil prices rocketed, in some places to ten times the level of a year earlier.

In November 1973, President Nixon asked the Congress for additional powers to meet the crisis and declared a "Project Independence" to move the nation toward self-sufficiency in energy by 1980.[5] Through early December, the Administration considered various rationing and gasoline tax proposals intended to cut supplies to motorists and thereby minimize the effects of fuel shortages on production and employment.

During that winter, conservation programs, warm weather, and reported leakage in the Arab oil embargo helped to keep the gap between supply and demand manageable, although many motorists were inconvenienced and utilities and large factories were forced to trim their fuel consumption.

On March 18, 1974, the emergency ended when seven Arab oil-producing countries lifted the embargo. By summer, domestic inventories had been restored.

But the die had been cast. In a brief 6 months the United States was forced to face an extremely distasteful fact—energy supplies would never again be as cheap, as plentiful, and as certain as they had been. The change would demand sacrifices of almost everyone.

EVENTS OF THE PAST YEAR

THE ENERGY PROGRAM

Project Independence

Under the leadership of the Federal Energy Administration, the executive branch in spring 1974 began the massive effort of preparing a blueprint for energy self-sufficiency. The effort involved hundreds of specialists from almost all federal agencies and dozens of contractors. The result was the *Project Independence Report*,[6] issued in November 1974.

The report was a comprehensive and detailed analysis of energy supply and demand through 1985. It systematically examined a range of possible policy actions in terms of broad strategic options. While stopping short of policy recommendations, it framed the issues and provided an overview of the tradeoffs. Some major findings of the study are:

- Both energy consumption and production are sensitive to price changes in the long run

- Oil imports will remain level or will rise in the next few years no matter what long-term actions are taken
- Coal production can increase significantly in the long run, but its role is limited by lack of markets
- Synthetic fuels will not be a major energy source between now and 1985
- Geothermal, solar, and other advanced technologies are large potential energy sources but will not contribute significantly until after 1985
- Continued problems with growth in the nuclear power industry are possible unless fuel cycle and reliability problems are resolved
- Accelerating nuclear powerplant construction will do little to reduce oil imports; in general, nuclear plants will replace new coal-fired powerplants
- Energy conservation can reduce annual growth of demand to about 2 percent between 1972 and 1985
- Literally all new domestic oil production that can be forecast is extremely uncertain because it is in such frontier areas as Alaska and the Atlantic OCS or results from new technologies such as improving enhanced recovery techniques.

Administration Proposals

Perhaps more important than the report itself were the general methodology, the analytical tools, and the data base that were assembled in its preparation. They became the basis for the energy policy recommendations that President Ford presented in his State of the Union Message in January.[7]

The President included in his message an omnibus energy bill, the Energy Independence Act of 1975, designed to provide the combined authorities necessary to deal with the nation's energy problems. In addition, he submitted several energy tax proposals and announced several administrative initiatives. The program is detailed in Table 13.

Central to the Administration program was the conviction that higher energy prices were necessary to encourage domestic production and discourage consumption. Several proposals were aimed at this objective—a petroleum excise tax and import fee, decontrol of domestic oil prices combined with a windfall profits tax, deregulation of natural gas, and a gas excise tax.

Other proposals to promote conservation through nonprice measures were energy conservation building standards, home insulation tax credit plus winterization assistance for low-income families, efficiency labeling for autos and home appliances, and voluntary agreements with auto and appliance manufacturers to improve product efficiency.

Proposals to increase energy supplies directly and to enhance fuel flexibility included exploration and development of naval petroleum

Table 13

Energy Proposals Described in the President's State of the Union Message

Energy Independence Act of 1975	Administrative initiatives	Energy tax bills
Title I—to allow use of Naval Petroleum Reserves for commercial purposes Title II—to provide for the construction and maintenance of strategic petroleum storage facilities Title III—to deregulate natural gas Title IV—to extend FEA authority to implement conversion from petroleum to coal for powerplants and other major fuel-burning installations Title V and VI—to amend Clean Air Act of 1970 to authorize compliance schedule extensions for SO_2, reschedule auto emission standards, extend deadlines for transportation control plans, delete the significant deterioration requirement, and other actions Title VII—to promote changes in state utility commission regulation by prohibiting suspension of proposed rate schedules for more than 5 months, eliminating prohibiting fuel adjustment clauses, eliminating certain cost exclusions from rate bases, and eliminating prohibitions of offpeak pricing Title VIII—to assure adequate planning for the siting of major energy facilities and the expeditious processing at the federal and state level of applications to site, construct, and operate energy facilities Title IX—to authorize and require tariffs, import quotas, or price floors to protect development of domestic petroleum resources Title X—to develop and implement minimum energy conservation standards to be applied to new buildings through state and local building codes Title XI—to assist state programs designed to winterize the homes of low-income families Title XII—to require labels on major appliances and motor vehicles displaying their energy use and efficiency Title XIII—to authorize a number of standby powers, including allocation and rationing, to deal with significant domestic energy shortages.	Import fee: a phased increase in the import fee on crude oil and petroleum products to $3 per barrel Crude oil price decontrol: price controls on domestic crude oil to be lifted Auto fuel economy: obtain agreements with automobile manufacturers to increase fuel economy 40 percent by 1980 Appliance efficiency: obtain agreements with manufacturers of major appliances to increase energy efficiency by 20 percent by 1980 Synthetic fuels commercialization: develop incentives program to ensure viable synthetic fuels industry by 1985.	Windfall profits tax: a tax on all domestic crude oil to capture the windfall profits resulting from price decontrol Petroleum excise tax and import fee: excise tax on all domestic crude oil and import fee imposed legislatively to replace administrative fee Natural gas excise tax: an excise tax equivalent to that proposed for petroleum Residential conservation tax credit: a 15 percent tax credit for the cost of such home improvements as storm windows and insulation.

reserves, construction of strategic petroleum storage facilities, conversion of major facilities from oil to coal, amendments to the Clean Air Act (discussed in the air pollution section of this chapter), assistance for energy facility siting, and development of a synthetic fuels commercialization program.

According to FEA estimates, the President's program would reduce petroleum imports by 1.2 million barrels per day in 1975, 2.2 million in 1977, and 8 million in 1985. The 1985 import reduction combined with emergency storage development and standby authorities would eliminate U.S. vulnerability to oil import embargoes.[8]

Congressional Response

The 94th Congress quickly responded to the President's initiative. In the *Congressional Program of Economic Recovery and Energy Sufficiency,*[9] released in February, the leaders of the House and Senate called principally for an attack on inefficient automobiles by a combination of taxes and rebates on new auto sales and by a 5-cent-per-gallon gasoline tax which would be set aside for an energy trust fund. On the supply side, they advocated a National Energy Production Board, import quotas, and extended allocation authority.

This early Congressional proposal, although in general accord with the President's goals, differed in philosophical approach. To reduce consumption and conserve energy, the President's proposals relied heavily on higher imported and domestic oil prices combined with voluntary conservation efforts. The Congress, while advocating energy conservation, espoused direct regulatory actions and specifically dismissed substantial energy price increases.

It was soon obvious that legislating energy policy would be a complex, controversial, and drawn-out activity. The difficulty of the subject matter was exacerbated by the jurisdictional divisions among key committees in both House and Senate, several of which shared responsibility for the vital components of an energy policy. In the House, for example, the critical, yet related issues of control of oil imports and domestic conservation through price mechanisms and by regulation are shared by the Committee on Interstate and Foreign Commerce and the Committee on Ways and Means. To come to grips with reform of outer continental shelf leasing, the House found it necessary to establish a select committee composed of members of four standing committees.[10]

The most forceful legislation to reduce dependence on imported petroleum was formulated by the House Ways and Means Committee.[11] Its bill relied primarily on oil import quotas to effect a reduction to 5.5 million barrels per day by 1980. Import licenses would be sold by competitive bidding at public auction, with the licenses fully marketable by the buyers. In addition, import duties up to $1 per barrel could be imposed, which was substantially lower than the President's proposal, and there would be a sliding-scale gasoline tax of up to 20 cents per gallon, depending on consumption levels during the previous years. This bill, however, was voted down by the full House.

ENERGY RESEARCH AND DEVELOPMENT

New Legislation

The issue of priorities in the conduct of federal energy research and development programs received detailed scrutiny by the Congress and the executive branch during 1974 and early 1975. The federal energy R&D budget has been heavily weighted toward nuclear power, with particular emphasis on the liquid metal fast breeder reactor (LMFBR). Nuclear power absorbed 56 percent of the fiscal year 1975 budget of $1,169 million for direct energy research and development; about 26 percent went to fossil fuel development.[12]

Recent energy supply problems, the relatively limited payoff to date from nuclear R&D, and increasing concern with the environmental and public safety implications of nuclear power resulted in much activity during the 93d Congress. Emphasis was on more diversity and balance in the R&D effort. Research and development for energy conservation, use of nonrenewable resources, and environmental protection were singled out in five new laws:

- *Energy Reorganization Act of 1974:* [13] Abolished the Atomic Energy Commission and created the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission. Some energy R&D functions of the Department of the Interior and other agencies were transferred to ERDA. The new federal realignment separates regulatory from development aspects of nuclear energy and centralizes the major energy R&D programs.
- *Federal Nonnuclear Energy Research and Development Act of 1974:* [14] Directs the Administrator of ERDA to design and conduct a comprehensive national program of research and development of all potentially beneficial energy technologies, with particular emphasis on energy conservation, environmental protection, and availability of adequate water supplies.
- *Solar Energy Research, Development, and Demonstration Act of 1974:* [15] Established a program of research and assessment of solar energy as a major source of energy and provided for development and demonstration of commercial use of solar energy.
- *Solar Heating and Cooling Demonstration Act of 1974:*[16] Provides for federal assistance for the development and demonstration of solar heating and of combined solar heating and cooling systems for residential and commercial buildings.
- *Geothermal Energy Research, Development, and Demonstration Act of 1974:* [17] Created a program leading to demonstration of technologies for the utilization of geothermal resources.

National R&D Plan

A major initial task of ERDA was preparation of a national plan for energy research and development.[18] Published in mid-1975, the plan set policy goals for energy research and development efforts:

- To maintain the security and policy independence of the nation
- To maintain a strong and healthy economy, providing adequate employment opportunities and allowing fulfillment of economic aspirations
- To provide for future needs so that lifestyles remain a matter of choice and are not limited by the unavailability of energy
- To contribute to world stability through cooperative international efforts in the energy sphere
- To protect and improve the nation's environmental quality by ensuring that the preservation of land, water, and air resources is given high priority.

The plan's primary purpose was to facilitate the shift from dependence on diminishing resources to reliance on less limited or unlimited resources. In the short-term (to 1985), research is generally related to enhanced recovery of oil and gas and to deployment of conventional nuclear reactors. In the mid-term (to 2000), existing liquid and gaseous fuels would be replaced by synthetics and less conventional energy sources such as solar and geothermal. In the long term, the plan looks to an all-electric society. Table 14 is ERDA's ranking of national R&D priorities. The plan is the first step of an ongoing planning process; it will be updated annually.

CEQ Role

The Federal Nonnuclear Energy Research and Development Act [19] directs the Council on Environmental Quality to evaluate the nonnuclear energy R&D programs in terms of their attention to energy conservation, the environmental consequences of application of new technologies, and environmental protection. CEQ is also directed to hold annual public hearings on the conduct of energy research and development and the probable environmental effects of the application of energy technologies.

Section 11 of the act instructs CEQ to consider in each annual report the probable environmental consequences of trends in the development and application of energy technologies. The discussion may be found in Chapter 3.

ENERGY RESOURCES

Conservation and Consumption

Many important questions of policy revolve around the sensitivity of energy demand to price changes. As described earlier, the Ad-

Table 14

National Ranking of Research, Development, and Demonstration Technologies

- Highest priority supply
  - Near-term major energy systems
    - Coal—direct use by utilities and industry
    - Nuclear—converter reactors
    - Oil and gas—enhanced recovery
  - New sources of liquids and gases for the midterm
    - Gaseous and liquid fuels from coal
    - Oil shale
  - "Inexhaustible" sources for the long term
    - Breeder reactors
    - Fusion
    - Solar electric
- Highest priority demand
  - Near-term efficiency (conservation) technologies
    - Conservation in buildings and consumer products
    - Industry energy efficiency
    - Transportation efficiency
    - Waste materials for generating energy
- Other important technologies
  - Underused midterm technologies
    - Geothermal
    - Solar heating and cooling
    - Waste heat utilization
  - Technologies supporting intensive electrification
    - Electric conversion efficiency
    - Electric power transmission and distribution
    - Electric transport
    - Energy storage
  - Technologies being explored for the long term
    - Fuels from biomass
    - Hydrogen in energy systems

Source: Energy Research and Development Administration, A *National Plan for Energy Research, Development, and Demonstration: Creating Energy Choices for the Future* (Washington, D.C.: Government Printing Office, 1975), p. VI–3.

ministration energy policy is based to a large extent on confidence that rising energy prices will work to reduce energy consumption growth rates. Others are less confident and on this point centers much of the current energy controversy.

Analysts hoped that post-embargo consumption figures would provide much needed precision to their estimates. But the task is not simple. Many factors other than price affect energy consumption—the inflation and recession of 1974, weather and temperature, and the emergency actions taken by federal and state governments. Another variable impossible to estimate is the effect of voluntary actions on the part of individuals, those not motivated by price or regulation but by a desire to do something useful for society as a whole.[30]

A rough reconciliation of preembargo fuel consumption forecasts for 1974 with actual experience is shown in Table 15. These preliminary figures indicate how price determines consumption. Although the shortfalls in demand attributable to price are not large

Table 15

Preembargo Energy Forecasts and 1974 Consumption

(In thousands of barrels per day)

	Motor gasoline	Distillate fuel oil	Residual fuel oil	Jet fuel	Electricity (In billions of kWh)
Preembargo forecast corrections for	7,035	3,560	3,150	1,090	1,956
Income	162	81	73	25	35
Weather	—	200	30	—	5
Embargo	60	40	40	—	26
Government action [1]	50	100	125	50	—
Corrected forecast	6,763	3,138	2,882	1,015	1,890
Actual consumption	6,582	2,966	2,688	995	1,864
Shortfall attributable to price increases	181	173	194	20	26
Percentage price increase	36	48	154	48	26

[1] Includes savings from coal conversion, allocations, airline route changes, speed limits, and other actions.

Source: Data Resources, Inc.

relative to the price increases experienced (and indeed may be overstated by inclusion of voluntary conservation), the nation had less than a year to adjust to fuel price changes, and presumably adjustment will continue beyond 1975. The cumulative effects of price increases will almost certainly continue to grow in the future.

Oil and Gas Development

Outer Continental Shelf Leasing In his State of the Union Message, President Ford reaffirmed that in line with the shift in emphasis to new domestic energy sources, accelerated leasing and development of the outer continental shelf is one of our highest priority energy programs.[21] A major hurdle to leasing on the Atlantic OCS was removed when the Supreme Court, in *State of Maine* v. *United States*,[22] ruled that title to the Atlantic coast offshore lands beyond 3 miles belongs to the federal government.

Accelerated leasing grew increasingly controversial. Public and Congressional concern centers on the environmental impacts, both offshore and onshore, of oil and gas production and whether OCS-generated revenues should be shared with the states. Another critical issue is the role of the states in planning OCS development. As of mid-1975 several legislative proposals to amend the 1954 Outer Continental Shelf Lands Act were under active consideration by the 94th Congress.[23] (See the coastal zone section of this chapter for further discussion of OCS issues.)

Deepwater Ports The Deepwater Port Act [24] authorizes the Secretary of Transportation to license and regulate operation of deepwater ports located off the U.S. coast generally for the purpose of

Oil and natural gas from 30 platforms in the Gulf of Mexico are gathered on this complex for processing and delivery to shore.

offloading oil from supertankers. It attempts to balance the need to streamline the regulatory process for siting energy-related facilities with the need to consider environmental criteria and state and local concerns.

Far offshore deepwater ports and the very large tankers that they serve have the potential for reducing oil spills resulting from vessel groundings and collisions. Larger tankers would make fewer trips to carry the same volume of oil, and the ships avoid crowded harbors and inshore waters.

If, on the other hand, more oil were imported because of the deepwater port, increased pollution is possible. New volumes of imported oil could require additional refinery capacity, and if the refined products were transported via tankers or barges, traffic at existing ports and in inland and nearshore waters would increase, thus increasing the risk of accidents.

The deepwater port would increase economic activity onshore and could result in higher local pollution levels and stresses on local infrastructure.

Under the act, the Secretary of Transportation is required to develop "environmental review criteria consistent with the National Environmental Policy Act"[25] and to use these criteria to evaluate applications. The act recognizes state and local concern about onshore impacts and requires the approval of the Governors of coastal states adjacent to the deepwater port. If a Governor notifies the Secretary that an application is not consistent with the state's programs relating to environmental protection, land and water use, and coastal zone management, the Secretary must condition approval on actions by the applicants that would make the deepwater port consistent with such plans.

Oil Shale In March the Department of the Interior and ERDA announced a program of accelerated oil shale in situ research.[36] Most plans for producing oil from shale involve, first, mining the oil shale by conventional surface or underground methods and then "boiling" it from the rock in a surface vessel, or retort. "In situ processing" involves heating the shale below ground. Only the liquids and gases are brought to the surface.

The goal of the accelerated research program is to develop several commercially viable in situ technologies by 1980. Industry was asked to nominate oil shale tracts which appear favorable to in situ methods and leasing of two tracts is expected by mid-1976. The program may be financed with private funds or with federal-private monies and where neither is feasible, wholly with federal funds. Although emphasis is on oil shale in Colorado, Utah, and Wyoming, oil shale deposits underlie much of the eastern United States. Feasible in situ technologies will be tested on various shale types.

The in situ program is encouraging because it minimizes the most serious environmental problems—a 50,000-barrel-per-day conventional retorting operation will generate nearly 60,000 tons of spent shale per day, enough to cover 20 acres of land to a depth of 1 foot.[37]

Aside from the difficult logistics of moving and disposing of this amount of material, successful revegetation of a disposal site is also a problem. Spent shale can be highly saline and its fine grains are sus-

Cliffs and canyon walls in Colorado contain the world's richest deposits of oil shale.

ceptible to wind erosion, making seed germination extremely difficult. Revegetation experiments are being carried out on a small scale.

In situ technology also offers the possibility of reducing the number of people required to operate the equipment, reducing the amount of water required, and increasing the recovery of oil.

Liquefied Natural Gas Existing and impending shortages of natural gas in the United States have given rise to plans for importing gas in a liquid form. LNG is formed by cooling natural gas to −260°F, when it occupies only one six-hundredth of its original volume. Large volumes of gas may then be transported economically in tankers specially designed to handle it.

The major environmental issue regarding LNG import is one of health and safety. If a tank containing LNG ruptured, large volumes of liquid hydrocarbons would quickly vaporize, posing a threat of explosion or severe fire. Thirty years ago it happened—an LNG tank in Cleveland failed. The liquid spread over a wide area and the vapor ignited and exploded, causing a second tank to fail as well. In neighboring residential and industrial areas, 128 persons were killed and estimates of injuries ranged between 200 and 400.[28]

LNG technology today is much better. Dikes surround tanks to contain spills, the behavior of protective materials at very low temperatures is better understood, and safety procedures are more comprehensive. Safety remains a concern, however, particularly when terminals are located in densely populated areas and tankers move through busy shipping lanes or confined waters.

So far, the only LNG importation terminals in operation in the United States are at Everett, Massachusetts, and Providence, Rhode Island. LNG is delivered to Everett by tanker and is trucked to Providence.

During the past year substantial public controversy arose over the Transcontinental Pipeline Company proposal to build an LNG terminal with three 60,000-barrel tanks in Gloucester County, New Jersey, near Marcus Hook. Controversy centered on the proximity of residential communities, traffic densities on the Delaware River, and neighboring industrial facilities that could be made more hazardous by nearby LNG.[29]

Meanwhile, construction of a similar terminal in a densely populated area of Staten Island was completed. However, decisions on construction of a connecting gas pipeline to New Jersey and the granting of an operating license to the Staten Island facility have not yet been made by the Federal Power Commission. A third LNG facility, at Cove Point, Maryland, is proceeding smoothly, in part because of its remote location. Built by the Columbia LNG Corporation, it is expected to be in operation by early 1977. In addition, three California locations were identified by industry for terminals to receive LNG from Alaska and Indonesia. The suitability of Point Conception, Oxnard, and Los Angeles Harbor is being studied by government and industry.[30]

LNG storage tanks under construction on Chesapeake Bay are expected to be operational by 1977.

Coal Development

Leasing A moratorium on additional leasing of federal coal, formally in effect since 1973, was continued in 1975 while the Interior Department developed a new leasing strategy. A moratorium was possible because extensive federal coal reserves (approximately 17 billion tons) already are under lease and about 90 percent of the existing leases remain undeveloped.

Much of Interior's effort during the past year focused on environmental impact assessment. In April 1974, a draft EIS for a new coal leasing program was released.[31] This impact statement was the subject of intensive scrutiny and comment by other government agencies and the public. A final impact statement, including a detailed description of the proposed program, is tentatively scheduled for later in 1975. In addition, under revised impact statement procedures, the department in October 1974 filed a final EIS covering approval of mining plans for four existing leases in the Eastern Powder River Basin.[32]

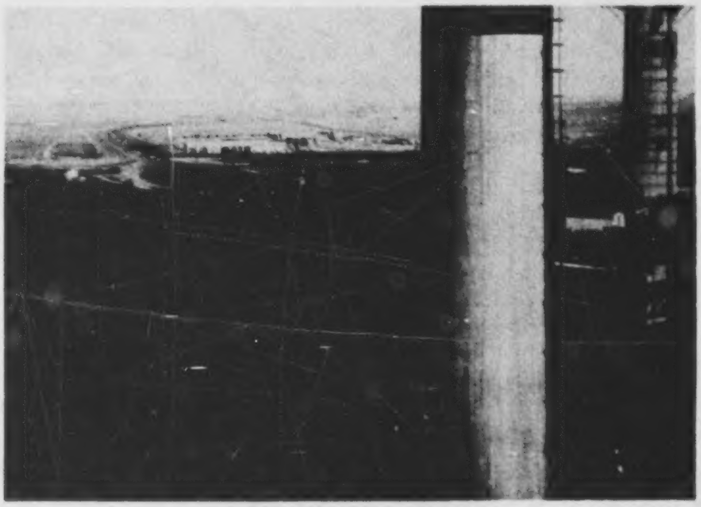
Interior's procedures for assessing the environmental impacts of developing the extensive federal coal deposits were challenged in court—in *Sierra Club* v. *Morton,*[33] the Court of Appeals for the District of Columbia found that a comprehensive program environmental impact statement for the entire Northern Great Plains, where most of the federal coal is located, would be required if the government proposed to develop coal throughout the region. Until the department decides on the extent of its coal program and meets the requirements of this decision, there can be no further federal coal development in the Northern Great Plains. This case is discussed in more detail in Chapter 6.

Coal Conversion The immediate environment-energy interface is most apparent in the conversion of large oil- and gas-burning facilities, primarily electric generating plants, to coal. After the October 1973 oil embargo, the Congress passed the Energy Supply and Environmental Coordination Act of 1974.[34] ESECA required the Administrator of the Federal Energy Administration to issue orders prohibiting any powerplant with the capability to burn coal from burning natural gas or petroleum products as a primary energy source. In addition, FEA may issue prohibition orders to other major fuel-burning installations, large factories, for example. In the short term, prohibiting consumption of natural gas or oil forces conversion to coal.

Before FEA issues such orders, several conditions must be met. First, the conversion must be technically feasible—the powerplant must have had the capability and plant equipment to burn coal as of June 22, 1974. Second, FEA must determine that:

- Burning coal is both practicable and consistent with the purposes of ESECA
- Coal and its transportation to end users will be available during the effective period of the order
- The order will not impair reliability or service of recipient powerplants.

FEA must make these determinations on technical and economic feasibility and practicability before issuing orders. The burden then



Extensive space and facilities are required at coal-fired powerplants.

shifts to the Environmental Protection Agency. The act gives EPA ultimate responsibility for deciding which plants may convert from oil or gas to coal by requiring EPA certification of FEA prohibition orders. Before an FEA order becomes effective, EPA must determine that:

- Primary ambient air quality standards will not be violated
- The plant will comply with any existing regional limitations
- Conversion does not create a significant risk to public health from concentrations of pollutants for which no ambient air quality standard has been determined
- The plant is on a schedule that ensures compliance with the state implementation plan no later than December 31, 1978.

When EPA determines that the above conditions are satisfied, FEA is notified and the order become effective. If at any time a converting plant fails to meet air quality requirements, EPA may initiate enforcement action or suspend the prohibition order. EPA may also suspend orders if plant emissions constitute a significant risk to human health. ESECA excludes action taken by EPA under the Clean Air Act from requirements of the National Environmental Policy Act. However, any FEA action that will be in effect for more than 1 year is subject to the full NEPA requirements.

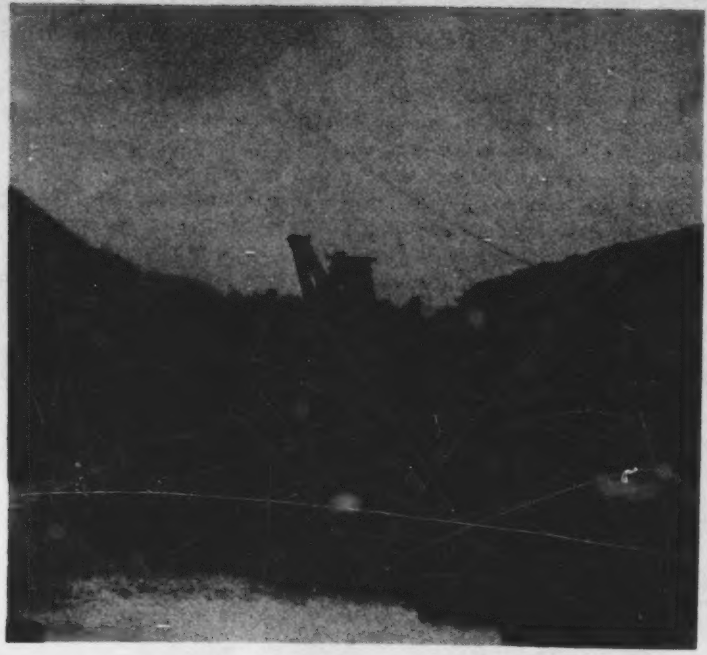
Surface Mining Late in 1974, the 93d Congress passed the Surface Mining Control and Reclamation Act,[35] requiring the Department of the Interior to review and set high standards for state regulatory programs. Several provisions were highly controversial, and when the President pocket vetoed the bill, he said that its unduly strict requirements would result in unacceptable coal production losses.

Early in February 1975, the President submitted a compromise bill to the Congress. Very similar to the one that he vetoed, the compromise bill contained some significant changes—provisions regarding citizen suits, stream siltation, and alluvial valleys were clarified and modified.[36] The Secretary of the Interior was authorized to interpret ambiguous terms and the reclamation fee was substantially reduced. Requirements for impoundments were liberalized and strict prohibitions against strip mining in National Forests were eased.

The Congress accepted several of these changes, but the bill that finally passed contained important differences. Once again, the President exercised his veto power, basing his decision primarily upon Administration analyses that the act would lead to unacceptable coal production and job losses.[37] In the face of strong Administration opposition, the Congress was unable to override the veto and the bill died.

Nuclear Power

The past year was one of difficulty for the nuclear power industry. Electric utilities were particularly hard hit by recession and inflation.



Local conditions govern the selection of surface mining equipment. The bucket wheel excavator and the shovel are both surface mining coal in southern Illinois.

Interest rates skyrocketed and bond issues found few buyers, causing severe problems in a highly capital intensive industry traditionally dependent on debt financing. At the same time, state regulatory agencies were reluctant to reflect soaring fuel prices in higher consumer rates. The result was an industrywide deficiency of capital funds for capacity expansion. Adding to the difficulties was the uncertainty of demand growth rates due to rising prices.

With this combination of factors, many new generating plants were either delayed or cancelled. Nuclear plants bore the brunt of the cancellations. Despite the problems, 14 new nuclear plants were licensed for commercial operation in 1974. By April 1975, 55 nuclear powerplants were producing 37,496 megawatts, 7.9 percent of the total U.S. electric generating capacity.[38]

Nuclear power continues to be controversial, and several heavily publicized incidents added to public concern. In October 1974 and January 1975, cracked pipes were discovered in some boiling water reactors which required the shutdown and inspection of similar reactors.[39] In March a cable fire in TVA's Browns Ferry Unit 1 closed down both Units 1 and 2; the Joint Committee on Atomic Energy called for a report on the incident.[40]

An independent and broad-ranging study of light water reactor safety was completed by a study group of the American Physical Society in April.[41] The report stated that it did not uncover any rea-

The Calvert Cliffs Nuclear Generating Station is under construction on the Chesapeake Bay.

sons for substantial short-range concern regarding the risk of accidents in light water reactors. This statement is in general agreement with Professor Norman C. Rasmussen's reactor safety study reported here last year. As a result of these safety studies, it has been argued that nuclear power should be pursued for its favorable economic advantage over oil- and coal-generated electricity; nuclear power saved U.S. electricity consumers over $600 million in the first half of 1975.

Several state laws reflect the public concern over nuclear power. Vermont became the first state to require legislative approval prior to construction of a nuclear powerplant.[42]

Perhaps most significantly, a nuclear safeguards initiative measure in California received enough signatures in May 1975 to be put before state voters as a referendum in June 1976.[43] The measure would establish a 5-year timetable for solution by the utilities and evaluation by the public and the state legislature of basic safety questions about nuclear fission powerplants and related facilities, especially insurance and waste disposal. Effective mid-1977, the public would receive full compensation in the event of a nuclear powerplant accident and would annually evaluate a citizen evacuation plan. Nuclear powerplants not approved would be subject to an annual derating of generating capacity. Although only 3 plants are now in operation in California, 6 more could be producing power within 10 years and as many as 60 by the year 2000. The impact of the measure could be substantial.

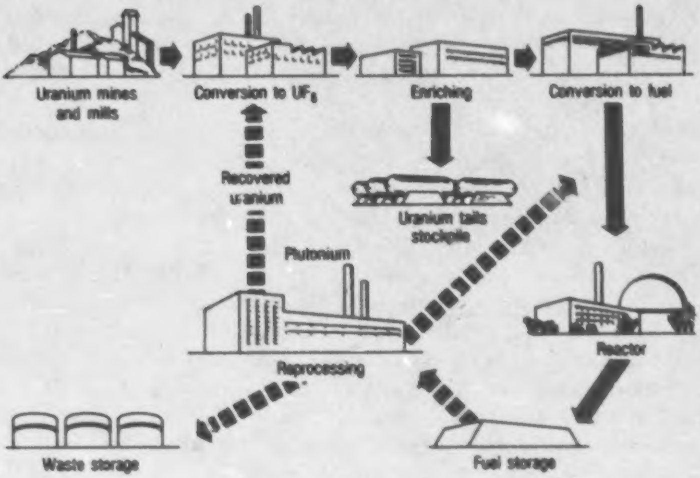
Fuel Cycle Issues Over the past several years environmental problems associated with nuclear power centered on reactor technology—on radiation standards, plant siting and safety, and thermal effluents. Attention is now focused more on the nuclear fuel cycle, and issues associated with the fuel cycle will remain important.

In many ways a nuclear powerplant is like a coal- or oil-burning powerplant except that the conventional steam boiler is replaced by a nuclear steam supply system and the coal or oil is replaced by a nuclear fuel core. The type of nuclear plant currently operating in the United States uses water to transfer heat from the fissioning uranium in the fuel core to the steam turbine and is called a light water reactor (LWR). As conventional powerplants depend on fuel for their operation and produce waste products, so do nuclear powerplants. The activities that comprise the supporting fuel cycle for the light water reactor are illustrated in Figure 7.

Uranium is found in pitchblende ore. The ore is extracted from sandstone deposits by either open pit or deep mining. From the 7 million tons of pitchblende mined in 1974, 12,000 tons of uranium oxide, U_3O_8, was recovered by milling.[44] The milled product, known as yellowcake, is purified for conversion to the gas, uranium hexafluoride, UF_6. Next, enrichment takes place to increase the concen-

Figure 7

The Light Water Nuclear Reactor Fuel Cycle


Uranium mines
and mills
Conversion to UF$_6$
Enriching
Conversion to fuel
Recovered
uranium
Uranium tails
stockpile
Plutonium
Reactor
Reprocessing
Waste storage
Fuel storage

Source: U.S. Energy Research and Development Administration, Nuclear Fuel Cycle: A Report by the Fuel Cycle Task Force (Springfield, Va.: National Technical Information Service, 1976), ERDA–33, Chart 4.

tration of U–235.* Jets of gas containing uranium molecules are injected into a system containing a porous barrier, through which a higher percentage of the lighter and faster U–235 molecules passes more easily than of the heavier U–238 molecules. The enriched gas mixture is converted to an oxide, UO_2, and is fabricated into pellets 0.5 inches in diameter and 1 inch long. These pellets are clad in metal and placed in rods which make up the fuel assembly.

In the light water reactor, most of the heat comes from the fissioning of U–235. Fission occurs when unstable isotopes of an element split into atoms of a lower atomic weight. The process is accompanied by the release of neutrons and a large amount of energy. Some atoms of plutonium–239 are also formed in the reactor when an atom of U–238 captures a neutron. For each gram of U–235 consumed as fuel, about 0.6 grams of plutonium is formed. Generally, over one-half the plutonium which is formed undergoes fission in the core, contributing significantly to the energy produced in the powerplant.[44]

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*The figures following the symbol denote an isotope of uranium. Isotopes are atoms that contain the same number of protons but a different number of neutrons. Two or more isotopes of an element exhibit similar chemical properties but different physical properties because of their different atomic weights. For example, uranium has three principal isotopes, uranium–233, uranium–235, and uranium–238. All contain 92 protons but a different number of neutrons. The natural abundances of U–235 and U–238 are 0.71 percent and 99.2 percent, respectively.

Light water reactors are partially refueled annually, with approximately one-third of the fuel assemblies replaced by fresh fuel each year. Spent fuel assemblies are stored under water in special pools at the powerplant for 5–6 months to allow the radioactivity level to decrease prior to shipment to a fuel reprocessing plant. There the spent fuel is reprocessed to recover the unused uranium and the newly created Pu–239.

The fuel reprocessing step of the nuclear fuel cycle also removes radioactive wastes which must be handled carefully to ensure that they do not enter the environment until their radioactivity is below harmful levels. Certain types of wastes are extremely dangerous to man and must be isolated from the environment for thousands of years.

Present federal regulations require that the liquid wastes created during reprocessing be converted to a solid and transferred to a federal repository within 10 years of their separation from the irradiated fuel.[45]

Plutonium Recycle The plutonium which is extracted from the spent fuel in the fuel reprocessing is a fissionable material and as such may be used as a fuel in the LWR. Its use as a fuel in the LWR is called plutonium recycle, and when it takes place, the fuel cycle is said to be closed. Because the plutonium produced in the LWR is valuable as a fuel, utility companies are anxious to use it to reduce the need for fresh uranium fuel. However, there is a significant potential problem.

Plutonium is also used in nuclear weapons. For this reason it must be protected from theft or diversion. Some people believe that plutonium should not be permitted as a fuel in reactors because it could become a target for theft. Because plutonium is highly toxic, especially when inhaled, the potential catastrophies warrant very high levels of protection.

In its draft environmental impact statement dealing with plutonium recycle, the AEC recognized the importance of adequate safeguards for the plutonium in various parts of the fuel cycle but took the position that the decision to permit plutonium recycle could be made in mid-1975 before a system of safeguards was designed, so long as the system was operational before recycle proceeded. In 1975, however, the newly formed Nuclear Regulatory Commission deferred decision on plutonium recycle until alternative safeguards systems studies were complete and a safeguards program designed and subjected to public review.[47]

Two pertinent studies were initiated during the past year by NRC in response to Congressional mandate within the Energy Reorganization Act.[48] The first is a national survey to locate and identify possible nuclear energy center sites large enough to support powerplants and other elements of the total nuclear fuel cycle. It will include a regional appraisal of the natural resources available for the sites and an evaluation of the likely environmental impacts of construction and operation of such energy centers. Two advantages of nuclear energy centers, or power parks as they are sometimes called, are that they would be easier to safeguard and could eliminate transportation of nuclear materials between separate facilities in the fuel cycle. The second NRC study will determine the need for and the feasibility of establishing a security agency to perform safeguard functions. The results of both studies are expected shortly.

The NRC is also analyzing alternative safeguards for plutonium recycle. The analysis includes facility protection measures, institutional and personnel security, transportation modes, and materials accountability. Study recommendations are scheduled for early 1976.

Radioactive Waste Management Disposal of radioactive wastes from the reactors is a unique and necessary part of the nuclear fuel cycle. Due to their toxicity, many wastes must be isolated permanently. Because high-level radioactive wastes generate significant amounts of heat, ways of using the waste as an energy source have been proposed. Some may provide radioactive isotopes for medical purposes. But there is no way to use all the waste material.

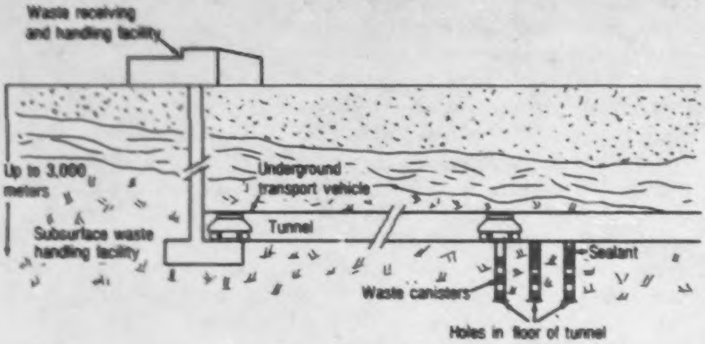
A variety of disposal methods has been proposed—storage in underground salt formations, further chemical separation of the waste to reduce necessary surveillance time, extraterrestrial disposal, burial in antarctic rocks, and interim near-surface storage in mausoleum-like structures. Surface storage in concrete casks was suggested in the draft EIS on waste management.[49] The proposal was widely criticized by citizen and environmental groups as well as by EPA for many reasons, in particular, that it did not respond to the need for ultimate disposal of radioactive wastes.

In April ERDA withdrew the draft EIS and its budget request for the surface storage facility, stating that a new study will encompass all environmentally significant waste-producing steps of the fuel cycle and ultimate disposal of radioactive wastes.[50] One waste disposal method believed feasible is burial in salt domes such as those found in New Mexico. An illustration of a deep geologic disposal scheme appears in Figure 8. The resolution of the waste disposal question will continue to be an important issue in the coming year.

Liquid Metal Fast Breeder Reactor (*LMFBR*) By far the most controversial nuclear issue in the past year was development of the LMFBR. "Fast breeder reactor" refers to nuclear reactors that—in addition to providing useful electric power—convert (or breed) abundant U-238 into fissile Pu-239 and thereby produce more nuclear fuel than they consume. The AEC and now ERDA have studied the breeder reactor concept for more than 20 years. About 8 years ago the government and industry launched an intensive effort to develop a commercial LMFBR. The primary goal is to demonstrate the commercial feasibility of the breeder concept by building and operating a 350-MWe powerplant on the Clinch River in Ten-

Figure 8

Solid Radioactive Waste Emplacement in a Mined Cavity



Source: U.S. Atomic Energy Commission, *High-Level Radioactive Waste Management Alternatives* (Springfield Va.: National Technical Information Service, 1974), WASH-1297, Figure 5.

nessee. At the Fast Flux Test Facility in Washington fuels and materials will be tested.

The major difference between LMFBR's and other reactors is that the central reactor core is surrounded by an outer core or blanket. The fuel rods in the central core contain a mixture of plutonium and uranium and the blanket is loaded only with uranium. As the plutonium in the central core fissions and releases neutrons, the neutrons interact with the U–238 in both core and blanket, transforming the U–238 into Pu–239. For every 4 pounds of Pu–239 consumed by the LMFBR, about 5 pounds will be created.

The LMFBR has two distinctive features. First, the LMFBR core employs "fast" neutrons, neutrons whose speeds have not been slowed by a moderating substance such as water. Second, the LMFBR uses liquid metal (sodium) to transfer heat from the reactor core to water, which is turned to steam to drive the turbine generators. These features give the reactor its name.

One basic advantage of the LMFBR is that it creates fuel from U–238, thereby greatly increasing usable resources. A second advantage is that the liquid metal coolant permits higher operating temperatures, thus making possible more efficient plant operations.

But the LMFBR has two major disadvantages. First, as we have seen in the earlier discussion of plutonium recycle, are the risks involved in handling large amounts of this more toxic substance safely and preventing its diversion. Second, sodium is extremely reactive chemically and its use as a reactor coolant creates significant safety problems.

The LMFBR program is opposed by many who say that health and safety issues make it unacceptable as an energy source. Proponents argue that the LMFBR and the fuel cycle can be operated in an acceptable manner.

Another concern is budgetary. Many believe that more energy R&D dollars should be diverted to the less hazardous sources of energy, such as solar and fossil fuel energy.

Much of the debate on the breeder centered around NEPA and impact statements on the program.[61] The proposed final EIS for the LMFBR program was released in December 1974. Public hearings on the LMFBR were held by ERDA in May and the NEPA review was complete by fall 1975. Current interest in the LMFBR program has shifted to the Clinch River demonstration plant.

An important issue is the differing views of the ERDA plant designers and the NRC licensing staff. The NRC staff maintains that an accident is possible which could result in melting the core. A "core disruptive event" could then result in a nuclear detonation. This type of accident is not possible in light water reactors due to a fundamental difference in its fuel (low enriched uranium) which contains less uranium than the amount needed to cause an explosion.

In order to prevent a nuclear explosion in the event of an accident in the LMFBR, the NRC staff believes that a device known as a core catcher installed below the reactor to disperse the molten mass that would result from a core disruptive event could prevent the molten mass from becoming critical (a necessary condition for a nuclear detonation). But the ERDA staff believes that the LMFBR can be designed so that the probability of a core-melting accident would be very low and an expensive core catcher would be unnecessary. Resolution of the two positions in the NRC licensing proceeding is likely to be a major issue in the coming year.

Reductions in fiscal year 1976 budget authorizations for the LMFBR program are a result of the anticipated licensing delay, not of lower priorities for the program.

Radiation The phenomenon of radioactivity was discovered a scant 80 years ago. Since then progress in understanding the atom has proceeded at an astounding rate. Yet in some respects our ability to put the atom to useful work has outpaced comprehensive understanding of its effect. Nuclear radiation is an immensely useful tool for improving the human condition. If not properly handled, radiation has the potential for great destructiveness. The issues currently facing society are concerned with differentiating constructive from destructive procedures.

In June 1975 EPA issued proposed environmental radiation exposure limits that are generally twenty times more restrictive than previous standards.[62]

At the same time, EPA issued standards limiting the release of long-lived isotopes—krypton-85, iodine-129, and transuranic* alpha-emitting elements with half-lives of over 1 year—throughout the entire nuclear fuel cycle.[53] For example, in its environmental impact statement for operation of the nuclear fuel reprocessing plant at Barnwell, South Carolina, the AEC had assumed that krypton–85 could be freely released to the atmosphere during fuel reprocessing activities. The proposed EPA emission limits clearly indicate that unrestricted releases will not be permitted. Containment of transuranic elements may become a major issue, especially if significant amounts are released during other fuel cycle activities than reprocessing.

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*Transuranic elements are those with higher atomic numbers than uranium (92) and are manmade.

Another unresolved issue concerns the effect of "hot particles." Controversy centers around the potential toxicity of small, insoluble particles of transuranic elements, particularly plutonium, when they are inhaled by human beings. These elements are found in irradiated reactor fuel or are the products of decayed irradiated fuel elements.

If such a particle remains in the lung, the tissue nearby is subjected to intense alpha radiation. The question is whether it is more likely that tissue in proximity to the hot particle will become cancerous than if the same amount of radiation were spread uniformly over the entire lung. If it were true that each particle has a relatively high probability of producing cancer, then release of plutonium and other alpha-emitting elements into the environment would have to be very strictly controlled, and there is considerable doubt that an energy system heavily dependent upon plutonium could ever be tolerated.

The level of risk to humans of hot particle inhalation is far from being proved, however, and the theory is not widely accepted among the scientific community at this point. A committee of the National Academy of Sciences has been convened to examine this question; its report, due shortly, should shed further light on this important matter.

International Events Safeguarding special nuclear materials throughout the world was an issue of increasing concern during the past year. India's detonation of a nuclear device made from plutonium produced in an unsafeguarded nuclear power reactor continued to have international repercussions. It has reinforced concern that international safeguards as administered by the International Atomic Energy Agency as well as the Non-Proliferation Treaty need to be extended to a wider range of countries and transactions. The IAEA is an international organization formed to promote, regulate, and safeguard peaceful uses of nuclear energy. Its safeguards program has as its goals the monitoring of nuclear materials and the detection and thus prevention of unauthorized uses such as the construction of nuclear weapons and explosives.

The continued growth in export of nuclear technology was demonstrated in June 1975, when West Germany and Brazil signed a nuclear cooperation agreement under which Germany will sell Brazil several nuclear power reactors and assist in providing a complete nuclear fuel cycle to support them.[54] Brazil will soon have the fuel enrichment and reprocessing facilities to convert its uranium to weapons-grade material.

Although there is no basis to believe that Brazil or any other nation will utilize its nuclear capacity irresponsibly, Brazil is not signatory to the nonproliferation treaty which is administered by the IAEA. The simple fact of nuclear proliferation raises many disturbing questions.

A controversy arose over shipments of plutonium oxide into New York's Kennedy Airport. The plutonium had been extracted from the spent fuel of a reactor in Italy and was being shipped to a nuclear facility in Pennsylvania for fabrication into fresh fuel elements to be used in the Italian reactor. Both the Mayor of New York City and the Governor of New York subsequently objected to the flights, citing the possible catastrophic effects of an air crash. However, in a suit filed by the Attorney General of New York, the U.S. District Court denied a request for a temporary restraining order to stop the shipments.[55] The NRC had previously announced plans to review its regulations concerning transport of radioactive materials, including plutonium.[56] In making this anouncement, the NRC also announced an interim position that shipments should continue during the review period.

In August 1974, a U.S. District Court ordered the AEC to complete its preparation and circulation of an environmental impact statement on the U.S. international nuclear power export program.[57] Activities to be addressed are uranium enrichment, delivery of special nuclear materials, and issuance of export licenses for reactors. In April 1975 ERDA issued an interim assessment which indicated that no significant adverse environmental effects were occurring during the NEPA review period and that the export program should be continued pending issuance of the draft EIS.[58]

Advanced Energy Sources

Solar Of the many new technologies currently being examined, the one nearest to contributing meaningfully to our energy supply is the solar heating and cooling of buildings. In contrast to the complex technologies—photo-voltaic conversion of sunlight to electricity and ocean thermal gradient conversion, which employs temperature differences between ocean depths as an energy source—solar heating and cooling are relatively simple.

Many materials for flat plate collectors are available. The principal impediment is not technology but the cost of materials used in solar heating and cooling; other barriers are institutional, building code modifications and new financing methods, as well as willingness to buy solar homes or to retrofit existing ones.

One major development in solar energy during the past year was submission to the Congress of ERDA's National Solar Heating and Cooling Plan [59] for implementing the Solar Heating and Cooling Demonstration Act of 1974.[60] The basic elements are to stimulate use of solar heating and cooling systems in at least 1 percent of residential and commercial building starts annually and to retrofit 2,500 residential and 200 commercial buildings annually by 1980. The plan could result in savings of over 10,000 barrels of oil per day.

The outlook for ultimate large-scale solar heating and cooling is quite favorable, especially in the sunny Southern and Western states, where residents faced with mounting fuel and electric bills will be attracted to solar energy.

Geothermal The only commercial geothermal electric generating facility in the United States is in the Geysers area of northern California. In 1974, output was 412 MWe (0.1 percent of U.S. electric power generation capacity). Annual increases of 110 MWe until 1980 are planned,[61] raising the figure to at least 2 percent of U.S. electric power from 1980 through 2000. Although nationally insignificant, geothermal power can supplement other forms of electric power in local areas, as it does in northern California.

Geothermal steam is also produced for space heating at Klamath Falls, Oregon, and Boise, Idaho. The development of geothermal energy was bolstered by passage of the 1974 Geothermal Energy Research and Development and Demonstration Act,[62] which directed ERDA and NASA to prepare a comprehensive program for developing the resources and demonstrating the technologies to use the energy. The federal program for geothermal development is basically resource exploration and assessment; environmental, legal, and institutional assessment; utilization; and advanced research and technology development.

During the past year ERDA completed its first Idaho geothermal well at the Raft River Valley site in south central Idaho at a depth of 5,007 feet. ERDA plans to develop the well in support of a field laboratory to provide design parameters for a possible demonstration powerplant.[63]

ISSUES TO WATCH FOR

ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION

It appears unlikely that any action will be so drastic as to change significantly the nation's energy consumption and production patterns in the near future. The alternative course is to rely on technology development for relieving energy stresses in the long run, which seems quite likely in view of recent decisions regarding federal organization and funding.

Because of this emphasis, the design of a national energy R&D program may be the subject of considerable interest and debate during the next several years. Issues of particular interest will probably be concerned with the following tradeoffs:

- Rapid versus long-term results

- Nuclear versus fossil fuel emphasis
- Program balance and diversity versus specialization
- Federal versus private participation
- Conservation versus resource development
- Environment and safety versus resource development.

REGIONAL VERSUS NATIONAL NEEDS

The energy crisis may well be defined as a problem of balancing regional interests against national needs. Examples abound—coal development in the West, OCS development off California, refinery siting in Maine—all must be balanced against national energy demands. No single region appears interested in sacrificing a traditional quality of life in order to supply other regions with energy. Even such long-standing energy-producing regions as the Gulf coast are concerned that other regions carry their weight in meeting national needs.

Alaska

Possibly the most important interface of energy and environmental values during the next several years is Alaska's. Most sensitive features are accentuated in Alaska—virgin wilderness, an extremely delicate and important ecological system, enormous energy supplies, little inherent local need for the energy resources developed, and a relatively undeveloped regional economy. Together these factors have the potential to generate considerable controversy over Alaskan development decisions. At the same time, they offer the opportunity to make Alaska a showplace of the rational resolution of controversy.

OCS Frontier Areas

As our nation attempts to move nearer independence from imported crude oil, exploration and production activity in the frontier areas of the outer continental shelf will increase. In January 1975, the Department of the Interior promulgated draft regulations for oil and gas operations in the Gulf of Alaska OCS.[64] The first lease sale was scheduled for late 1975, and subsequent sales in the Atlantic OCS will be held in mid- to late-1976. As events approach exploration and production, regional debate will intensify. The ability of the federal government to meet the coastal states' needs in the process of developing the OCS will be critical.

Northern Great Plains Coal

A recent report, *Effects of Coal Development in the Northern Great Plains,* issued by the Northern Great Plains Resources Program,[65] illustrates the regional nature of problems associated with coal development. The group concluded that secondary impacts—those resulting from the additional industrial and commercial development ancillary to the primary coal development projects—may well be the most significant impacts of developing the region's coal resources. Some other conclusions are:

- The population increases attributable to coal development will be large compared to existing local populations
- The rapid influx of population will increase demands for services
- Public service requirements will increase at a much faster rate than revenue collection, especially in the early years of development
- Three service areas are of particular concern—housing, health care, and education
- Many Indian reservations will be affected by coal development, for some reservations contain considerable coal deposits and some of these lands have been leased
- Coal development will accelerate the urbanization process that is occurring in the Northern Great Plains region.

ENERGY TRANSPORTATION

Energy development alternatives are interdependent with transportation alternatives. As energy production in the West and other regions increases, the environmental consequences of transporting the energy will become an increasingly important issue.

There are three basic systems which have been given serious consideration. An example is the transportation of coal or energy derived from coal—mine mouth electrical power generation with transmission to the consumer via extra high-voltage lines; mine mouth coal gasification or liquefaction and transport of fuel gas or liquid by pipeline; and coal transport by slurry pipeline, rail, or a combination rail/barge system to the point of energy consumption.

The transportation mode chosen will depend to a great extent upon the priorities of the states with the energy resources. If jobs and incomes, as opposed to environmental preservation, are the objective of a state's coal development policy, then programs to encourage the mine mouth gasification or liquefaction of coal would tend to be emphasized. On the other hand, exporting coal via slurry pipeline or unit train would reduce the kinds of changes listed above in the discussion of Northern Great Plains coal. Export would also require less onsite water than mine mouth electric power generation or coal gasification.

NUCLEAR POWER

The commercialization of nuclear power led to the emergence of several hotly debated issues during the past few years. There will undoubtedly be more.

A slurry pipeline requires less onsite water than mine mouth electric power generation or coal gasification. Prior to injection, the slurry is stored at a facility like this one at Black Mesa, Arizona.

Plutonium Recycle

The Nuclear Regulatory Commission must make major decisions concerning the acceptability of plutonium as reactor fuel and the safeguards that must accompany such use. These decisions will greatly affect near-term industry planning on fuel reprocessing, fabrication, and spent fuel storage. Perhaps more important, they will have strong bearing on the acceptability and cost of commercial use of the breeder reactor.

Radioactive Waste Disposal

The federal waste disposal program has been redirected by ERDA away from immediate implementation of an interim storage plan and toward examination of a permanent solution. An environmental impact statement will be prepared on the new program. It will be scrutinized closely and will almost certainly be controversial.

International Nuclear Exports

The continued deployment of nuclear technology in foreign countries is a matter of urge[illegible]ncern to the United States. ERDA's program environmental impact statement on the U.S. nuclear export program will provide the basis for further debate but not for resolution of the problems of international nuclear proliferation.

LAND AND WATER RESOURCES

Land and water resources account for a wide range of environmental issues, from irrigation to transportation and from historic preservation to refinery siting. Perspectives on such issues are provided here in three sections on land use, the coastal zone, and water resources. Land use was treated extensively in a separate chapter in last year's Annual Report; the other two are presented for the first time and, therefore, contain substantial background information.

There is no generally agreed-upon strategy for resolving many of our difficult land and water resource problems. In part this is because there are no broadly accepted goals. Some believe that more water resource projects will solve environmental problems and others claim that they will only make things worse. Some believe that more land use regulation is essential, and others decry an excess of controls. In the coastal zone, a debate is underway over which level of government should exert what authority over energy facilities, resort developments, and other proposed actions. Further, even assuming some agreement on land and water resource goals, there are few measures of success in meeting them. That is one essential contrast with pollution issues, where progress is measurable in reduced pollutants.

The tradition and nature of federal involvement in land and water resource issues are especially varied. There is a long history of federal assistance for a broad range of water resource programs, beginning early in the last century with navigation improvement. On the other hand, federal aid to coastal states for resource management is quite recent, dating from the 1972 enactment of the Coastal Zone Management Act. The federal government has long supported a number of land use planning assistance programs, which until recently have tended to relate to single-purpose programs such as highways, schools, and housing. At the same time, the federal government's regulatory programs and funding of public works have major effects on land use at the local and regional levels. The traditional concern that authority over the use of private land be limited at all levels of government, especially at the federal level, has made the Congress reluctant to enact a broader program of assistance to states for land use. Yet a number of states have enacted comprehensive land use legislation, and nearly all others have taken at least some steps to broaden their regulatory authority.

It is difficult to tell what the future portends for many land and water resource issues. There is growing interest in the use of easements and other nonstructural land use controls as alternatives to the traditional structural solutions of water resource problems. Coastal zone management has gained impetus from the decision to develop OCS oil and gas in new areas; a number of proposed amendments to expand the program are now under consideration by the Congress. By contrast, the focus of efforts to improve land use has shifted from the federal level to states and localities, where many innovative ways to manage growth and to regulate land use are being tried out.

COASTAL ZONE

BACKGROUND

The coastal zone is narrow in extent but broad in human and ecological significance. The unique value of coastal lands and waters is well-recognized in the laws that single them out for protection and in the special regard that we have for our 100,000 miles of U.S. shoreline.

What makes the coastal zone a special place, worth special efforts to preserve? First, the majority of us live near coastlines and millions more vacation there. All over the world people cluster near coasts; in the United States, 53 percent of the population lives in coastal counties bordering the Great Lakes, the Gulf of Mexico, and the oceans.

The juncture between land and water is also a scene of great biological importance. The plant and animal life of the sea is exceptionally abundant near the shore. Most of the fish in the world's commercial harvest depend on coastal waters for nurture at some stage of their lives.[1]

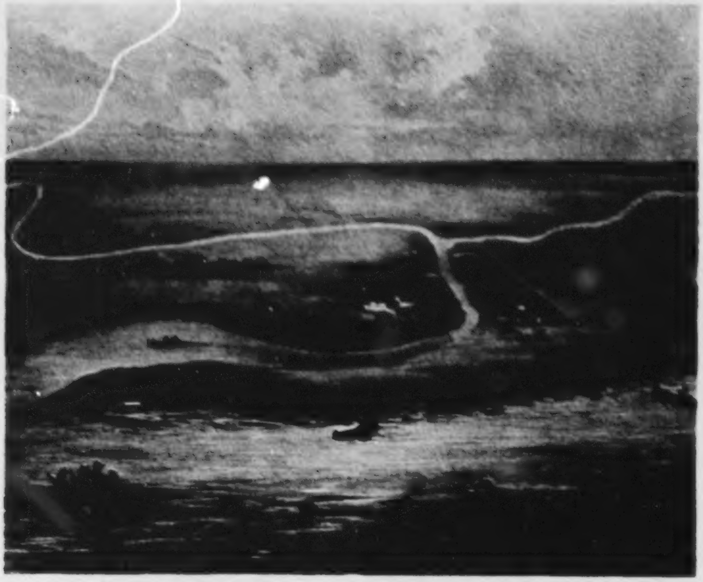
Besides providing food, living space, sport, and scenic beauty, coastal regions are in heavy demand for other purposes too. They serve as waterfront sites for industry, especially powerplants, with their large demands for cooling water; as sinks for wastes, not only from coastal communities but also from farms and industries upriver; for ship channels, harbors, and marinas; for building lots and space for airports and highways, newly created by dredging and filling wetlands; and as a vast mine for natural resources—above all, oil and gas.

It is clearly impossible for the limited lands and waters of the coastal zone to serve all these purposes at once. Precisely because they are valuable for so many uses, they are vulnerable to pressure from too many competing, conflicting demands.

In recent years, energy development has become preeminent among competing claims on the coastal zone. The President is committed to rapid development of oil and gas from untapped areas of the outer continental shelf, such as the Gulf of Alaska, the Atlantic, and new regions of the Pacific off California. Superports for supertankers, authorized by the federal Deepwater Port Act of 1974,[2] are another likely new development.

In some cases the onshore effects of both these energy developments will be significant, especially the indirect effects on jobs, incomes, houses, schools, public services—in short, on the social and economic structure of coastal communities.

There is, however, a framework of laws governing management of the coastal zone that could serve as a starting point for dealing with these changes and conflicts.



The changing uses of the Lake Michigan shore in the span of a century and a half are shown in two views of the same location in Chicago, 1820 and today.

Wetlands and Estuaries

Concern for tidal waters and wetlands was the impetus for many of the laws protecting the coastal zone. The center of the great biologic fertility of coastal waters is wetlands and estuaries, where the sweep of the tides mixes salt water with fresh once or twice a day. Salt marshes in temperate zones and mangrove swamps in the subtropics are among the most productive environments on earth. Their output of plant material equals that of tropical rain forests; they are twice as productive as ordinary farmland.[3] Sheltered estuaries, rich with these nutrients, support two-thirds of the commercially valuable fisheries of the U.S. Atlantic coast and Gulf of Mexico.[4] The value of tidal waters and wetlands does not end there. They also help to buffer shorelands from storms, and they have a natural capacity to remove pollutants and purify air and water if they are not overloaded.

Although the greater part of the nation's endowment of wetlands still survives, a significant portion has been lost in this century. Ecologists John and Mildred Teal estimate that from 1922 to 1954, productive shallow coastal water and marsh in the United States shrank from 7.4 million acres to 5.3 million—a loss of more than 25 percent in 32 years. On the Atlantic coast alone, the loss for the first half of the 20th century was one-half million acres.[5]

California, which had little to begin with, has lost more than half its original estuarine habitat—102,000 acres out of 197,000 (excluding San Francisco Bay).[6] Sixty percent of the 313 square miles of wetland that originally surrounded San Francisco Bay has been filled and diked.[7]

The leading cause of estuarine loss, according to the Interior Department's comprehensive study of estuarine pollution, is dredging to maintain navigation channels and suffocation from dredge spoils. Close behind in importance is deliberate filling for residential or commercial buildings. In Louisiana, dredging and filling for oil-related activities (laying pipes, building docks, and the like) are the prime cause of loss.[8]

Several states, including Connecticut, Georgia, Maryland, Massachusetts, and Virginia, have put their wetlands under special legal protection, and most states require permits for dredging or filling or draining them. Wetlands are also coming under the shelter of state management plans for the coastal zone.

Coastal Zone Management

Among the states with broad legislative authority over land use in coastal zones are California, Delaware, Maine, New Jersey, Rhode Island, and Washington. Unusual features in the Delaware and California laws make them of special interest.

Delaware's 1971 Coastal Zone Act bans outright new heavy industry within 2 miles of its 120-mile coast.[9] Other states which regulate coastal development rely on permit systems rather than the flat prohibition that Delaware puts on such heavy industry as refineries, petrochemical complexes, steel mills, and paper mills.

True to the California tradition of leading the way in environmental matters, California's Coastal Zone Conservation Act was the first in the country to require a comprehensive plan for resource use in the coastal zone.[10] Placed on the ballot by initiative in November 1972, it passed with a favorable vote of over 55 percent.

The plan will cover the coastal strip between mountains and sea, generally about 5 miles wide, plus the sea waters under state control, the length of California's 1,100-mile coast. It includes the marine environment, coastal land environment, geology, appearance and design, recreation, energy, transportation, development intensity, and government organization. It will be presented to the California Legislature at the end of 1975. Meanwhile, nothing of any substance may be built on the coast between the 3-mile seaward limit and 1,000 yards inland from high water without express permission from the state Coastal Zone Conservation Commission or one of six regional commissions.

In addition to state law, coastal zones are also covered by a unique federal land use law, the Coastal Zone Management Act of 1972.[11] Land use laws with broader coverage have so far failed to pass the Congress, and the Administration does not at present support them. The Coastal Zone Management Act is therefore a pioneering effort in collaborative planning among the United States, the states, and local communities for the use of land. This innovative law established a voluntary program in which all 30 coastal states and 3 of the 4 territories have chosen to participate. Its chief purpose is to encourage the states to balance needs and make deliberate choices among the myriad claims on coastal resources.

Tropical beach in Puerto Rico is a valuable part of our 100,000 miles of shoreline.

Federal grants help the states to inventory their valuable features—fragile natural areas, essential fish and wildlife habitats, historic places, prime beaches and other open spaces, and settled communities; to establish priorities for land and water uses; and to plan for natural resource protection and orderly development, keeping in mind national as well as local and regional needs.

The spirit of the law is cooperative and consultative. An unusual feature is that it pledges the U.S. government to abide by state programs for managing coastal resources. The Secretary of Commerce may reject state programs but once they are approved, the federal government must make its own actions consistent, so far as practicable, with the states' management programs. To get federal permits for activities in the coastal zones, private parties must also have certificates of consistency from the states.

The Coastal Zone Management Act also supports state efforts to preserve wetlands and estuaries with a joint federal-state program, including funds for matching state grants, to establish estuarine sanctuaries. The Marine Protection, Research, and Sanctuaries Act of 1972 (the Ocean Dumping Act) makes a further federal commitment to preserve marine areas of singular ecological, aesthetic, or recreational value by designating them marine sanctuaries and by providing funds.[13]

EVENTS OF THE PAST YEAR

Energy was in most of the headlines on matters affecting coastal zones in the past year, but meanwhile the states were making quiet progress with comprehensive plans to manage their coastal resources. An important question was how best to mesh energy development and coastal zone planning.

Offshore Oil and Gas

The uncertainty of future energy supplies from Arab countries and the certainty of present high prices for oil made development of oil and gas from new, untapped areas of the outer continental shelf a matter of high national priority in 1975. With it there appeared to be a national consensus that energy development should—and could—proceed in accord with high standards of environmental protection.

Concern for the coastal environment marked the public debate on OCS development in frontier areas. There was widespread agreement on the need to replenish old, declining oil fields with new discoveries as part of the effort to end overdependence on foreign oil. But leaders in the states and cities near the new areas raised objections to leasing unless their concerns were adequately addressed.

The Administration goal of leasing 10 million acres in 1975 envisioned offshore development unlike any that the United States has experienced. Under this schedule oil and gas rights on nearly as much acreage as had been sold in the entire 22 years of federal OCS leasing would have passed in 1 year from public ownership into private hands. The goal proved impracticable, and the Interior Department eventually discarded the concept of leasing a predetermined number of acres per year.

Predevelopment Review Plans devised to meet the concerns of the coastal states included the idea of separating decisions to lease and explore on OCS tracts from decisions to produce. As matters now stand, when the government sells OCS leases, no one knows for certain whether oil and gas are present or how much is there; exploratory drilling is the only way to find out. But once a lease is sold, the buyer controls the timing of both exploration and development, subject to government approval of detailed operating plans. Government review in the past has stressed safety and conservation. Only rarely has it looked at projected development in terms of broader impacts.

The chief advantage claimed for separating leasing and exploration decisions from development decisions is that the government could more effectively deal with all the impacts of OCS development, including onshore impacts. The separation would provide a second decision point, at which all parties could consider how best to develop discovered oil and gas in the light of more complete information about both environmental and other consequences. It would tell coastal states in time to plan for the onshore effects exactly where and when and what kind of oil development could be expected.

While supporting the Administration position opposing change in the Outer Continental Shelf Lands Act, Interior has made changes in its OCS procedures in the past year and is contemplating more. The department recognizes that federal-state coordination is a must, because authority over offshore oil production is divided. The federal government has complete control of U.S. waters beyond 3 miles offshore, but the states are sovereign onshore and in the territorial waters inside the 3-mile limit, where support facilities for offshore drilling must go.

In May Interior announced that it was establishing a high-level OCS Advisory Board, through which it would consult with coastal state Governors before making major policy decisions affecting OCS development. Although Interior did not bind itself to follow the OCS board's recommendations, it did promise to give them full consideration and also to disclose promptly all the policy options being considered.[11] Besides this national policy board representing all the coastal states and several federal agencies, regional committees formed by the states may deal with specific issues affecting their own areas.

Two issues that the policy board will face are the separation of exploration from development and possible financial aid to coastal communities affected by OCS development. The Interior Department has endorsed the principle of a broader and more detailed joint state-federal review process after exploration but before development of oil and gas finds.[14] In mid-1975, the department was working on the mechanics, giving special attention to conforming OCS activities with state coastal zone management plans. At the same time the Congress was considering amendments to the OCS Lands Act of 1953, including a proposal to require separate permits for exploration and development.[15]

Aid to Coastal Communities Interior was also considering the question of impact aid, as were the Congress, other federal agencies, state and local bodies, and private groups. It should perhaps be noted here that although all direct taxes, bonuses, and royalties on OCS petroleum accrue to the federal government, state and local governments collect revenues from oil activities in federal waters indirectly through sales, income, and onshore property taxes.

The effects of oil development, for good or ill, on nearby communities are not easy to sort out. While many communities may benefit from OCS development, others, especially small rural ones with little experience with industry, may face timing and planning problems.

Some of the most intense activity in OCS oil development comes at the beginning. The exploratory stage of drilling for oil requires experienced oilmen, who throng into frontier oil areas from distant places and move on when the job is finished. The next step, development, involves a small army of construction workers to build docks, terminals, storage tanks, and possibly refineries. Construction takes far more workers than production of oil or operation of refineries. Long in advance of production, then, there are increased demands on community services.

Whether these demands prove negligible or burdensome depends to a large degree on the character of a community. In metropolitan, heavily industrialized areas such as Boston, New York-Northern New Jersey, the Delaware estuary, or southern California, the impact of OCS development is likely to be slight relative to the large economic base and extensive community infrastructure already in place. Where the OCS area is remote and community infrastructure is virtually nonexistent, as in several of the Alaskan coastal areas, the oil companies themselves will be obliged to provide facilities for their employees during exploration and development.

Where an established onshore oil industry is declining, as in Louisiana and southern California, offshore development could gradually replace the older oil industry with little noticeable impact. Another factor is the availability of local labor. If OCS activity can put the local unemployed or underemployed to work and if an influx of excess jobseekers can be avoided, demands for extra community services will be limited.

Still another factor is the existence of other oil and gas development besides that on the federally owned outer continental shelf. Alaska, for example, has an active state program of oil and gas leasing both onshore and offshore in state waters. Where some of the onshore facilities can serve federal as well as state development, the impact of OCS activity is correspondingly diminished.

For small communities with no oil experience and little industry or economic diversity, offshore oil development can be a classic boom and bust experience. Demands on the local community to supply new roads, new schools, more police, parks, libraries, and hospitals can be lessened to the extent that the oil companies themselves make provision for their employees during the boom stages of exploration and development.

An important consideration is the length of time that exploration and development are expected to last. Where development is gradual, an orderly, phased expansion of public facilities and services taking advantage of tax revenues from new arrivals may be possible. Where it appears that the exploration and development phases will be short, temporary expedients may be more acceptable. Without careful planning, communities could be stuck with facilities that they no longer need when the boom subsides.

Planning can also help to buffer the less tangible impacts—the possible "culture shock"—of rapidly transforming a quiet fishing or farming backwater into an oil and gas center. The United States has little experience with sudden OCS development; oil production in the Gulf of Mexico evolved gradually from an established onshore industry. The Scottish experience in the North Sea, where oil production is expected to reach Gulf of Mexico levels after a brief 10 years of development, is more apposite. In particular, the remarkable success story in the Shetland Islands, where planning was done well in advance to cope with the influx of oil, is relevant to newly developing areas in the United States, especially Alaska.[16]

The remote, sparsely settled Shetlands, inexperienced with oil or indeed any industry, are the chosen site for a deepwater port to handle North Sea oil. Among the anticipated effects are a rapid increase in population, from about 17,000 in 1971 to 30,000 by the early 1990's. A community such as Yakutat, Alaska, with its 600 people, mostly Tlingit Indians, faces roughly similar impacts as a staging area for Gulf of Alaska operations. According to oil industry estimates, Yakutat's population could rise rapidly to 2,400 with OCS development; other estimates put the expected increase still higher.[17]

Shetland County's response to oil development was to adopt a plan containing onshore oil facilities at one site only and to select several villages for planned development to house newcomers. The county's planning effectiveness was greatly aided by a parliamentary grant of extraordinary planning powers and was supported in part by oil industry financing.[18]

As OCS development in frontier areas becomes imminent, several approaches to dealing with possible impacts on coastal communities have received attention. Among them are municipal bonding, impact aid, loans or loan guarantees, and federal revenue sharing.

Conditions in the Gulf of Alaska may prove similar to those in the stormy North Sea, where this drilling rig is operating.

In many cases, communities that anticipate the need for new services will be able to borrow in the bond market on the strength of prospects for enlarged revenues. Municipal bonds that require no payments for several years are available. But difficulties may arise if there is unanticipated delay, as in the case of the Trans-Alaska Pipeline, which came along 5 years later than many Alaskans expected. In cases of protracted delay, a community might have to begin payment on the bonds before the larger tax base has developed.

The possibility of delays and cancellations suggests that communities should exercise caution in building structures and services too far in advance of assured demand. The result could be idle capacity as well as onerous fiscal burdens on permanent residents.

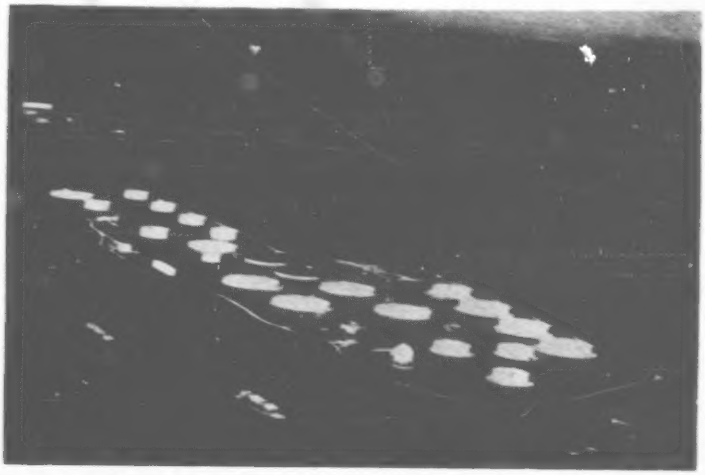
These problems indicate the importance of early disclosure of exploration and development plans, thus reducing uncertainty. Requirements that applicants for development permits provide information to affected states and submit development plans to them for review and comment are being developed by the Department of the Interior.

Another proposal to help coastal communities affected by OCS development is impact aid—with grants and loans to be made at the times and places that they are most needed. Grants have been proposed for planning or to compensate for adverse impacts where they cannot be helped or to ameliorate them where they can. If a community could show that outlays for new roads, schools, police, and so on will exceed revenue from the expanded tax base, it has been suggested that grants might be appropriate. Where adverse impacts are temporary and are followed by long-term net benefits, loans or loan guarantees have been proposed.

Other proposals include various revenue sharing plans to share with coastal states the royalties and bonuses that the federal government receives for offshore oil. One problem with such revenue sharing is that it does not provide funds during exploration and development when, if help is needed, it will be needed most. It must wait upon production and that may be 5 years from the time of discovery. Revenue sharing might also distribute funds in a manner unrelated to need. Communities that may need help have no assurance that they will get enough at the right times, while others with little or no need might receive most of the revenues shared. A further difficulty is that coastal states would get the lion's share of a resource that in fact belongs to all citizens.

Another view is that existing federal programs are adequate to provide any impact aid that may still be needed after the companies make provision for their exploration and development personnel and the communities make normal municipal financing efforts.

These are the kinds of issues that planning for OCS development impacts must deal with. Another aspect of the oil supply program is where to put the onshore facilities to handle new offshore oil and gas or expanded oil imports.



Onshore tank storage for offshore oil places demands on coastal land. These tanks are on drained marshland in the lower Mississippi near the Gulf of Mexico.

Refinery Siting

Refineries, the oil storage tanks that serve them, gas handling facilities, and the petrochemical plants that follow in their wake create the biggest siting problems. It is petrochemical plants that most worry the local citizen concerned with effects of oil and gas development. After the construction phase, refinery employment is limited—400 to 600 jobs in a large, modern 250,000-barrel-per-day refinery. In an allied petrochemical complex there are about eight times as many jobs.[19]

So long as OCS oil simply replaces crude oil imports, there will be no call for new refineries and other facilities to handle it. For net additions in capacity, there is a good deal of choice about location.

Present facilities may be enlarged. Or new plants may be built in highly urbanized and industrialized areas. Both options take advantage of community services and buildings already there and draw upon an established work force. Changes in the local economy and in the flavor of community life would be relatively small, and cities with chronic unemployment would benefit.

At the same time there are smaller towns and rural places that might also welcome oil-related industry for the jobs that it would bring. Private companies often prefer such grassroots locations because land there is cheaper and easier to assemble.

Other options have to do with location on waterfront sites versus sites farther inland. Refineries and related facilities tend to cluster near where the oil comes out of the ground or where it comes to port from abroad. Safe, cheap transportation of crude oil by pipeline permits considerable flexibility to locate refineries inland. Coastal zones have other features, however, that add to their attractions as refinery sites—the water that refineries and petrochemical plants need for cooling and processing is at hand, and water transportation is available for shipping refined and manufactured products to market.

In 1975, there was no immediate urgency for new refineries. In fact, there appeared to be a surplus of refinery capacity.[20] Petroleum demand averaged under 17 million barrels per day in 1974; at the end of the year, refinery capacity was 19.4 million barrels per day in the United States and the nearby foreign countries that regularly supply the U.S. market. In the spring of 1975, the *Oil and Gas Journal* reported "one of the lowest refinery utilization rates in history."[21]

There was thus no rush for early construction. The exigent feeling of a few months earlier that refinery sites must immediately be found, indeed imposed by a superior siting authority on the reluctant east coast if necessary, had evaporated. The respite provided a calm interval in which to consider refinery needs for the longer future, when the recession would have lifted and the demand for oil would resume growth.

Although capacity at existing sites has been substantially increased, there has been no large new east coast refinery, built from the ground up, since 1958. The chief reasons had to do with economics and supplies of crude oil. Community opposition, especially in the coastal zone, was responsible for stopping a number of refinery projects. Some proposals, however, have recently met with considerable public acceptance, and in 1975 two plans for large new refineries, one in Baltimore and one in Portsmouth, Virginia, appeared headed for approval and an early start.

It is instructive to look at the coastal communities that welcomed new refineries and those that turned them down to see what elements make this kind of development acceptable or repugnant to the people who are going to live with them.

A community that balked at the idea is Durham, New Hampshire. This college town, a few miles from New Hampshire's 18-mile shoreline, voted 9 to 1 against the late Aristotle Onassis's plan to build a huge 400,000-barrel-per-day refinery. The state Legislature backed up the town's right to make its own choice.[22] Afterwards, the 1974 New England Coastal Zone Management Conference pondered the kind of refinery proposal that would be acceptable to New England. A participant from a business firm suggested a large inland site of 1,000 acres or more, most of it to be kept in a natural state. If no more than 50 miles from Boston, it could be economically attractive.[23]

The Durham Board of Selectmen advised refinery planners to make an extensive survey of sites and to justify their first choice. They recommended study of the social and environmental structure of the community and candor about the reasons for buying land (Onassis's representatives had bought options on 25 percent of the land in Durham without revealing their purpose). Further, the public should be kept informed.[24]

Some of these precepts were put to the test in nearby Sanford, Maine. This inland town, a dozen miles from the seacoast, was hard hit when textile mills moved out in the late 1950's. Sanford gained a national reputation as "the town that wouldn't die" for its successful efforts to attract new industry—plants that make everything from carpets to wooden heels to small electric components to civilian aircraft.

At a special town meeting in May 1974, the New England Energy Company readily won rezoning for a refinery to be supplied by pipeline from Portland 40 miles away. A town referendum supported the decision, by a vote of 3 to 1. Opposition developed at hearings the following winter before the state siting authority, the Board of Environmental Protection. Most came not from working class Sanford but from nearby towns which depend on farming, fishing, and tourism. The Sanford proceedings have been indefinitely suspended—not because of local opposition but because the company encountered financing problems.[25]

Portsmouth, Virginia, is another town that welcomed a refinery. Heavily dependent on the U.S. Navy for jobs, this city of 106,000 in

Virginia's tidewater region had been inviting industrial development on the refinery site for years. In February 1975, the city council voted 6 to 0 to rezone a 628-acre site on the waterfront for the Hampton Roads Energy Company's 175,000-barrel-per-day refinery. Mayor Richard J. Davis stressed jobs and higher taxes as reasons for supporting the refinery application.[26]

Crown Petroleum Company's application to build a major 200,000-barrel-per-day refinery in Baltimore's industrial south end received the same kind of enthusiastic backing from the city government. In fact, Baltimore officials lobbied heavily—and successfully—with the Legislature to exempt the Crown Petroleum project from a bill requiring both state and local permission to build coastal facilities for offshore oil and gas.[27] The city of Baltimore wanted no delays or interference with the new refinery's progress.

Another town illustrates environmental protection and employment benefits that are distinctly at odds. Eastport, Maine, is a declining fishing village of 2,000, too remote to attract many tourists; it has been described as a Down East Appalachia. What it does have is a natural deepwater port, the asset that attracted the Pittston Company to propose a $500 million, 250,000-barrel-per-day refinery.

In March 1975, the Maine Board of Environmental Protection approved Pittston's refinery proposal but turned down plans for a supertanker pier on the grounds that maneuvering the large, unwieldy vessels to the proposed site would be too hazardous. Eastport has frequent fog, rough weather, rocky shores, strong currents, and powerful tides; in fact, supertankers could not have approached the pier at all except at slack tide.[28]

The board banned tankers over 70,000 tons from the proposed pier and asked Pittston to find a safer way to transport crude oil to the refinery. Within 3 months the board approved a renewed application specifying that tankers up to 150,000 tons may bring in crude oil so long as the tidal current is not over 1 knot. The board also required that all tankers entering the harbor have double bottoms.[29]

The most telling argument in favor of the Pittston proposal was that Eastport needs jobs. There was much popular support in the community for a refinery. On the other side of the argument is the exceptional danger of oil spills in the risky sea approach to the Pittston site. In fact, it is far from certain that the refinery will be built because part of the approach to Eastport is through Canada's Head Harbour Passage. The Canadian government strongly opposes the transport of oil past important fisheries and lobster fields.

What are the lessons that can be drawn from these examples? First, it is not impossible to win community acceptance of new refineries. Economics and experience are strong determining factors. Communities where jobs are scarce, especially cities and towns with industrial experience, are likely to approve refinery applications. Approval is much less likely in pastoral places where fishing or farming are thriving, or in vacation areas, or in prosperous white collar towns.

A second important factor is environmental safety. Although Maine's Board of Environmental Protection came down on the side of industrial development in Eastport, where the choice seemed to be jobs versus the environment, Canada's opposition to the risky project may yet determine the outcome. One may conclude that it behooves refinery planners to consider carefully the physical environment as well as the economic needs and social character of a community before making a proposal.

Deepwater Ports

The Deepwater Port Act of 1974, signed on the fourth day of January 1975, authorizes the construction of ports to receive supertankers in U.S. waters beyond the 3 miles that the states control.[30]

No port on the U.S. Atlantic and Gulf coasts can handle the very large crude carriers of 200,000 tons deadweight and more which regularly carry crude oil in the world's trade. Most are restricted to tankers of 35,000–50,000 tons. West coast ports are deeper, but Seattle, which has the deepest harbor in the lower 48 states (73 feet), still cannot handle the largest of tankers afloat today, the 375,000- to 500,000-ton supergiants that have drafts up to 90 feet.

In mid-1975, demand for oil imports was below expectations because of the recession and high prices. Plans for three deepwater ports in the Gulf of Mexico were proceeding, but not with quite the urgency of a year or two earlier. The Louisiana Offshore Oil Project (LOOP) off Grand Isle appeared nearest to realization of the three. Originally it was intended to receive 3.5 million barrels per day. By the summer of 1975, 9 of the original 18 oil companies in the consortium had dropped out, and the project was slated to begin at a more modest capacity of 1 million barrels per day, with possible later expansion.[31]

The two other superports in the Gulf which have applied for federal licenses are Seadock, a privately backed proposal near Houston, and Ameraport, due south of the Alabama-Mississippi line, which the states themselves are supporting.[32]

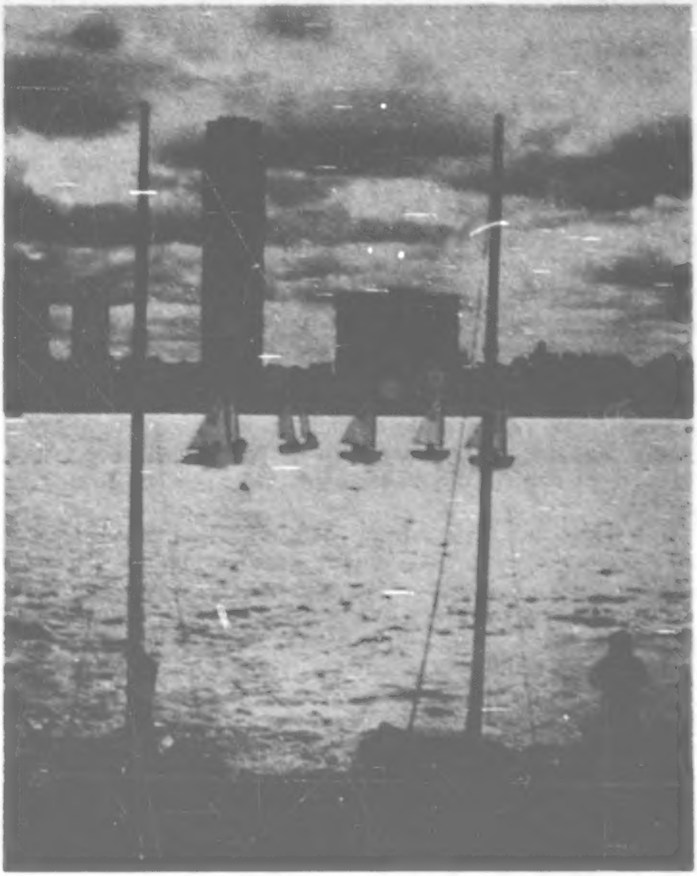
The three superports are all planned as monobuoy ports, 20 to 30 miles from shore. With pipeline delivery to shore, offshore location is a good choice environmentally; it keeps supertankers out of crowded harbors where dangers of collision are greatest, and oil spills occurring farther from shore are less likely than nearer spills to reach sensitive estuaries and valuable, scenic beaches. In addition, weathered oil that has been exposed to air and water for some time is considered less toxic than a fresh spill.

Within the 3-mile limit where the federal Deepwater Port Act does not apply, there are proposals for building or expanding capacity to receive large tankers. Estero Bay in mid-California already has an offshore mooring for supertankers; oil companies have applied to the

Corps of Engineers for a permit to add more. At Corpus Christi there is an elaborate plan, still in early stages, to dredge and deepen the harbor inshore and to add deepwater port capacity in U.S. waters.[33]

The plans presently underway are in locations which have experience with oil and land facilities to handle it. Onshore impacts are not likely to be great. In the Gulf of Mexico, much of the increase in crude oil imports would simply replace declining production from old fields.

Many of the rough spots in regional energy development will be made smoother as coastal zone management plans mature. One of the goals of planning is to designate places where energy facilities are



The Charles River and riverbank near Boston Harbor accommodate recreation, commerce, and living space. Coastal zone planning must include these and many other uses of land and water.

desirable or tolerable and other areas where they are definitely out of bounds.

The Coastal Zone Management Program

It is the job of coastal zone planning to make choices among the myriad valuable uses which are competing for the limited space in coastal lands and waters. Planning, of course, is not a magic talisman. Designating permitted uses while forbidding others is bound to be controversial. For example, Delaware's Coastal Zone Act, which takes a hard and fast position against any new heavy industry in a 2-mile-wide coastal zone, has been criticized as a deterrent to new industry and more jobs. It is also accused of eroding the state tax base. Defenders of the Coastal Zone Act point to Delaware's lower than average tax bills for the typical family and generally good employment record. They credit it with preserving a quality of life that is valuable to most people in the state. A strong effort to repeal it, backed by the industry-labor alliance which has opposed it from the outset, failed in the 1974 legislative session.

California California, which is further along with a comprehensive coastal management plan than most other states because of the mandate in its own coastal zone conservation law, is in the thick of controversy over priorities. Real estate agents, developers, oil and gas interests, logging companies, and construction trade unions have attacked California's regional coastal commissions and the state's comprehensive plan for what they term a no-growth policy. A Malibu real estate agent said that restrictions on new development in the coastal zone were "one of the most intensified forms of discrimination I have ever come across." [34] Predictably, there were also criticisms that the state commission was too lax in letting development proceed while preparing its long-range master plan.[35] In fact, about 95 percent of applications has been approved.[36]

A draft version of the commission's plan was the subject of 20 public hearings in April and May attended by some 6,000 people. The plan stressed coastal development that serves the whole public, such as campgrounds and motels rather than private homes; protection and restoration of coastal marshes; preservation of farmlands and a change in tax laws to reduce the pressure for urban development; and meeting energy needs by a "vigorous program of energy conservation" along with stringent environmental safeguards for any energy installations on the coast. The commission recommended siting away from the immediate shoreline any new development that would block public access to the oceanfront.[37]

To take effect, the California plan will have to be adopted by the Legislature. One hurdle that it must clear is the problem of state planning versus local control of land use. Among the severe critics of the plan are local governments. Jealous of their planning and zoning powers, they want to preserve their freedom to act on matters affecting their chief tax base—real estate. The state commission's latest

California's coastal zone plan stresses public access to the seashore; this scenic stretch is at Point Lobos near Carmel.

recommendation calls for 3 more years of interim state authority over critical coastal areas. Ultimately, primary regulatory authority would pass back to local governments after they revise their land use plans to bring them into conformity with the state coastal plan.[28]

The federal Coastal Zone Management Act broke new ground in federal-state relations on land use. In developing their coastal management programs under the act, the states are attempting to reconcile federal and state objectives; at the same time they are grappling with delicate problems at the next level in government relations.

Washington The first state to submit a coastal zone program for federal review was Washington, which had a head start because of its own state law requiring special protection and planning for the coastal zone. Adopted by referendum in November 1972, the law provided the framework for a comprehensive coastal zone management program.

Washington's program asserts a special statewide interest in all its shorelines, 200 feet inland from high tide. All major shorelines—from the Pacific coast to all the large bays, lakes, and rivers, together with their wetlands—are areas of special statewide significance. The program puts the highest priority on protecting the natural character of important shorelines, on favoring long-term over short-term benefits, on protecting the resources and ecology of the coastal zone, and on making publicly owned areas more accessible.[29]

Local governments were charged with making shoreline inventories, developing master plans for the inshore areas, and setting up a permit system to govern substantial development on the shorelines. Active citizen involvement was a basic ingredient; more than 2,000 people participated in creating the 39 county and 66 city plans that cover the state's shores. By the end of 1975, all local plans are to be submitted to Washington's Department of Ecology for review. If a local government fails to make a plan, the state may step in and do it. Only the inland city of Spokane, whose shoreline is river and lake front, has so far failed to make a plan. If the state is not satisfied with a local master plan, it can send the plan back for revision. Most of the plans have in fact been revised—some several times—to bring them in line with state standards.

The state has the power to turn down a local plan entirely and substitute one of its own devising. But this is a last resort which the state does not wish or expect to use. Instead, it is relying on cooperation and consultation to iron out disagreements. The state may also review local government decisions on permits for shoreline building, but in case of disagreement a hearings board, or ultimately the state courts, will resolve the issue.

Washington's program was clear and specific in its approach to state-local relations. On federal-state coordination it was less precise. For this reason it won only preliminary approval from the Commerce Department and was sent back for better definition of how the state program and the activities of numerous federal agencies which have an interest in the coastal zone may be meshed. This coordination is an essential step for an undertaking that pledges the federal government to make its actions consistent with state coastal zone programs.

Maine Maine, which submitted a preliminary coastal zone management plan for the middle section of the state in February, withdrew it in July. The chief reason was the unsettled nature of state-local relations. Maine's preliminary plan had stated a philosophy that "actual planning decisions *should* be made at local or regional levels with only limited state guidance." [40] But putting the philosophy into practice is not easy, especially in a state with a tradition of prickly independence in town government.

Maine actually has some powerful state authority to regulate the use of land, including coastal land. Its Site Location of Development Law requires a state permit for any large development occupying more than 60,000 square feet.[41] Its Wetlands Protection Act allows the state to restrict the use of wetlands.[42] Unless an owner challenges them in court and wins, the restrictions become a permanent easement. And the Mandatory Shoreland Zoning and Subdivision Control Law of 1971 requires that Maine's cities and towns zone their shorelines (within 250 feet of high water) to control rapid urbanization and preserve natural beauty, clean water, wildlife habitat, and access to the water.[43]

The Shoreland Zoning Law set a deadline of July 1, 1973, for the zoning ordinances. If local governments did not zone their shorelands, the state could do the job for them or it could put a moratorium on any development in the shorelands until zoning was in effect.

All but 30 of Maine's 440 towns and cities missed the deadline.

And many of the 30, according to the Coastal Planning Group, had made only "weak, inadequate or token attempts to comply with the law."[44] The state did not immediately exercise its prerogative to impose zoning ordinances. Instead, it extended the deadline and offered help. There were still difficulties, however, and the state did eventually impose a 1-year moratorium in some 200 towns.[45]

Most of Maine's towns are small—95 percent have fewer than 5,000 people, and 90 percent less than 500. Few have the experience or technical expertise for developing land use controls; in all likelihood, some have no inclination.

Maine's state coastal zone planners conceived a leading role for regional commissions in making detailed plans for shoreline communities. The state for its part offered guidance. It has developed a register of critical areas, among which are hazard areas like flood plains; areas that are worth special efforts to preserve, such as historic and scenic places, economically valuable resources, and important habitats; and areas that are under special pressure for development. The state has also mapped the whole coastal zone, rating areas for their suitability as sites for industry or commerce or for large residential developments.

By early 1975, 60 out of 83 towns in Maine's midcoast region had zoning ordinances; it was this area that was covered in Maine's preliminary coastal zone program.[46] At hearings on the environmental impact of the program, representatives of town after town spoke up against what they saw as too much state and regional control. They made it clear that they wanted to take charge of their own planning in their own way. Maine's Independent Governor, James Longley, supported the towns' demands that coastal zone planning funds go to them directly rather than to the regional commission so that towns can hire the regional talent as consultants if they wish and use the state's guidance as they wish.

Though state coastal planners modified the mid-Maine program to take account of the towns' objections, Governor Longley withheld approval, and the program was withdrawn to await a thorough thrashing out of the state-local control issue. It was anticipated that a revised Maine coastal zone program would cover the whole state.

Estuaries, Wetlands, and Marine Sanctuaries

The great biological importance of wetlands and estuaries is becoming widely recognized, and recent state laws to protect them are making a strong impact.

New Jersey provides a notable example of wetlands protection. In the 1950's and 1960's, an annual average of 3,800 acres of coastal wetland was destroyed. The state's 1970 Wetlands Act, which requires a permit from the Department of Environmental Protection before wetlands may be dredged, filled, or altered in any way, reversed the trend.[47] In 1973, 35 acres of wetland was lost and in 1974, 105 acres. In the first 29 months of New Jersey's permit program, the department received 100 permit applications, decided on 62, and turned down only 2 outright. Much of the department effort was in working with developers to redesign projects in order to save wetlands.[48]

Supplementing state efforts to save wetlands through permit systems is the estuarine sanctuary program of the federal Coastal Zone Management Act. The first sanctuary established under the program is South Slough in Oregon. This untouched area, an arm of Coos Bay, is representative of Pacific Northwest estuaries, which are not plentiful on this geologically young seacoast. Many of the estuaries that did exist have been filled for development or dredged to make harbors for the timber trade.

South Slough had not been disturbed because it lacked access, but development was on the way. There were two plans to fill and use the area—one for houses and one for a campground complete with television hookups. Local citizens began the effort to save the estuary and persuaded the county that it was worth preserving. In June 1974, a federal grant of $825,000, to be matched by the state, was awarded for purchase of 4,400 acres. Later, $300,000 was added to the grant.[49]

The program's second grant will help to preserve the famous estuary of the Duplin River and Sapelo Island, Georgia. The Sapelo Island Research Foundation, which now owns the land, has nearly depleted the funds left to it by the late tobacco merchant, R.J. Reynolds. One of the great benefits of saving this estuarine system is that it has been studied by University of Georgia scientists for 20 years and thus provides invaluable baseline data. If it were developed, much of the value of those data would be lost. A $1.5 million grant from the federal Office of Coastal Zone Management, plus an equal or larger amount from the state of Georgia, will establish the 9,000-acre sanctuary.[50]

Another area under consideration is Old Woman's Creek, Lake Erie, not far from Sandusky, Ohio. Strictly speaking, it is not an estuary because it is fresh water, but it is a significant habitat for young bass, muskie, and pike. The grant proposal originated with the environmental group which has worked hard to clean up Lake Erie, the Center for Lake Erie Area Research, and is backed by many others, including the Audubon Society and the League of Women Voters.[51]

The marine sanctuary program of the federal Ocean Dumping Act of 1972 is one more resource for the preservation of important coastal ecosystems and for saving significant historical, aesthetic, and archeological sites as well. So far only one grant has been made. The place where the *Monitor* went down 16 miles off Cape Hatteras is now a marine sanctuary. The aim was to save the *Monitor,* the first iron warship and an important relic of the Civil War, from salvagers.

A likely candidate for designation is the area just seaward of Florida's John Pennekamp State Park off Key Largo. Here there is an important coral reef to be saved both for ecological purposes and for recreation and aesthetic pleasure.[52]

ISSUES TO WATCH FOR

For the near future, the big issue in the coastal zone will surely be the same as this year's headline issue—energy. Drilling for oil and gas on the OCS frontier is at the heart of the matter.

OCS Development

In 1975 various bills to modify the OCS leasing program were before the Congress. Whether through a change in the law or a revision of the rules by the Interior Department, a process for a more detailed review of development plans after discovery appeared certain.

The main purpose of this new process would be to permit a joint review by federal, state, and local authorities of plans to develop the oil. The best time to plan for the onshore impacts of oil development is at this point—after exploration has shown where the oil is and how much is there.

Interior's proposal for reviewing the impacts of offshore drilling in the frontier areas is to do it in two stages. Each frontier area would be the subject of a full environmental impact statement prior to leasing. Then after exploration a company that has found oil would submit a detailed lease development plan along with details of planned onshore facilities and pipeline locations. Specific information to be required will be defined by Interior after consultation with the developers and states involved and with the OCS Advisory Board. Before the developer is given a permit to produce, state and local officials would have an opportunity to review the development plan and the related onshore information to be sure that they are consistent with approved state coastal zone management programs. A second environmental impact statement would be required if Interior's decision on the development plan fits the NEPA criteria of a major federal action.

Another set of issues has to do with the need for aid to communities involved with offshore oil, from what government and private sources any such aid might be provided and what form it may take—whether revenue sharing, loans, grants, or other.

Refinery Siting

The first question about refineries and related industrial development is whether we need more of them. And, when there is a need for more, will there be real problems in finding sites? Experience shows that most refinery expansions meet with little opposition and cause few negative impacts. New grassroots refineries are often welcomed in communities with industrial experience, especially where jobs are scarce.

Coastal Zone Planning and Regulation

As coastal zone management programs evolve, they are bringing into prominence two important questions. One has to [illegible] with levels of government—the relations between nation and state and between states and localities. Some interests in the coastal zones are broader than local, and they are best protected at the state or even national level. Yet local government does represent some very immediate interests of the people who live there, interests that may get lost at the statehouse or in Washington.

The other not entirely separate question is that of economic growth and its relation to environmental protection. There is no certain and necessary conflict between economic growth and environmental quality. What conflicts do exist have sometimes been exaggerated. But there are genuine conflicts. The virtue of coastal zone planning is to make them explicit, to lay out the arguments on each side, and to help citizens to make reasonable—and reasoned—choices.

LAND USE

BACKGROUND

Wise use of land is an environmental challenge to any society. In a nation like ours—with a different body of land law in each state, a great variety of landscape, and a strong sense of the rights of the property owner to determine the best use of his land—it is difficult to define and measure good land use, and people often disagree on which direction marks progress.

For many years our land ethic was one of unrestrained use, development, abandonment, and waste made possible by what seemed a limitless supply. As the finite nature of our land becomes more evident, so does the importance of efforts to balance private land rights with considerations of the public good.

What is the public interest in our land resources? Land uses to provide food, natural resources, and living space are most basic. The way that we use land also influences how it cleanses air, holds water, grows renewable resources, provides recreation, and supports populations of all living things.

A broad and expanding range of issues related to land use derives from these elemental needs. Urban land issues include revitalizing downtowns, preserving neighborhoods, providing decent housing, and settling on the right mix of transportation modes. In fringe areas the issues may be curbing sprawl, locating different densities of development and controlling its environmental costs, providing services in a timely and cost effective fashion, and protecting prime farmlands. Among the key issues in the countryside are establishing sound grazing and forestry practices, assuring ample output from farms, allocating scarce resources such as water, and deciding how and where to permit energy-related development. In short, there are few economic, social, energy, or resource issues that lack a land use element.

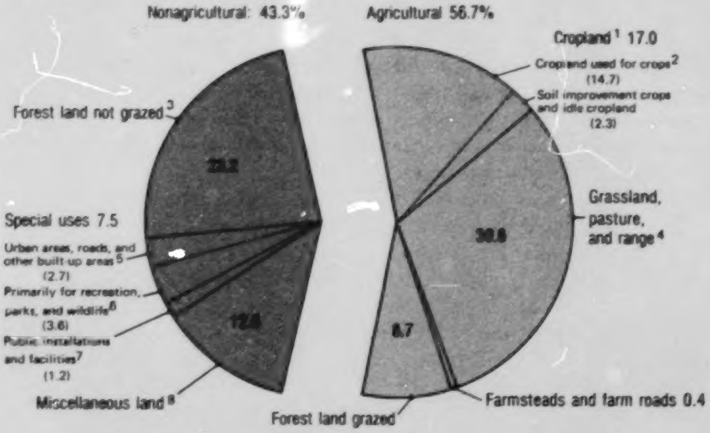
The Supply of Land

The United States is comprised of 2.3 billion acres of land. The federal government owns one-third of this, mostly in the Western states and Alaska. State and local government and Indian tribal holdings are small, so that nearly all the rest of the land is in private ownership.

Over one-half of the total U.S. acreage (57 percent) is classified as agricultural, although only about one-fourth of that (15 percent of the total) is cropland used for crops (see Figure 9). Nearly all the remainder is grasslands and grazed forest. Of the land classified as nonagricultural (43 percent of the total), more than half is forested. Most of the rest is marsh, open swamp, desert, tundra, and the like, which may have great ecological value but offer limited scope for

Figure 9

Major Land Uses



[1] Excludes cropland used only for pasture.

[2] Cropland harvested, crop failure, and cultivated summer fallow.

[3] Excludes 32 million acres of reserved and other forest land duplicated mainly in parks and other special use areas. It was not feasible to eliminate all overlap that exists because of multiple use.

[4] Includes cropland used only for pasture.

[5] Urban and town areas; highway, road, and railroad rights-of-way; and airports.

[6] National and state parks and related recreational areas, national and state wildlife refuges, and national forest wilderness and primitive areas.

[7] Federal land administered by the Department of Defense and the Atomic Energy Commission and state land in institutional uses.

[8] Includes miscellaneous uses not inventoried and areas of little human use such as marshes, open swamps, bare rock areas, deserts, and tundra.

Source: Based on U.S. Department of Agriculture, Economic Research Service, *Major Uses of Land in the United States: Summary for 1969,* Agr. Econ. Rep. No. 247 (Washington, D.C.: Government Printing Office, 1973), Table 2.

development by man. The most commercially valuable of the remaining acreage is the 60 million-plus acres (less than 3 percent of the total) which is classified as urban areas, roads, and other builtup areas.[53] This small part of America's whole domain is at the center of land use decisions. It is where most of us live, where most business and commerce are located, and where most of the irreversible commitments to intensive land use have been made.

The Dynamics of Land Use

Shifts in Categories of Land Use From a national perspective, changes in the amount of land in each category occur slowly, but at local and regional levels the shifts may be quite significant. Although land in urban areas is only 1.5 percent of total U.S. land today, the figure has doubled since 1950. Land designated for recreation and wildlife has tripled in the same period and now amounts to 4 percent of total acreage; annual additions are averaging more than 2 million acres.

Each year about 1.25 million acres of rural land, one-third of it cultivated cropland, is given over to intensive use. Chief among the uses are urban expansion, which takes an average of 740,000 acres of rural land every year, including 250,000 acres of cropland. Transportation projects in rural areas consume 130,000 acres annually, and reservoirs take an additional 300,000 acres.[54]

Demographic Factors The growth in U.S. population continues to slow. With the number of citizens now about 215 million and with the lowest birth rate in our history, projections for the year 2000 have been lowered from the 300 million estimated 5 years ago to 264 million.[55] Slower population growth, characteristic of the past 30 years, may combine with other factors to reduce the pressures to expand cities. Personal lifestyle preferences, housing costs, energy costs, and environmental controls are other important factors in determining whether urban growth will subside. Population trends are discussed further in Chapter 3.

While the westward movement of the U.S. population center continues, the pace is slower. The general movement of the population to coastal areas also appears to have slowed except for a few places like Oregon and Florida. The five Great Lakes states in fact lost 100,000 persons by outmigration during 1974.[56] Nevertheless, coastal counties continue to be prime areas for conflict among competing land uses.[57]

Both population distribution and patterns of urbanization are influenced by the size and number of households. This is especially true in the 243 metropolitan areas where two-thirds of our population lives. The clear trend is toward smaller households and more of them. The average household declined from 3.67 persons in 1940 to 2.97 in 1974. There are now 70 million households in the United States; with today's population, if household size remained unchanged since 1960, there would be only 57 million.[58] The trend toward fewer children per family makes for smaller average household size, as do the tendency of young people to leave home at an earlier age and the trend toward separate housing units for elderly people who can afford to live alone. These trends have important land use implications—demand for smaller housing units and ready access to community facilities that serve the needs of the groups represented in the new households.

In recent years these changes have been especially important in suburban areas, where over one-third of our population lives. Not long ago, these areas provided housing primarily for families with school age children. Now there is a demand in the suburbs for a broader range of housing and facilities to fit the new patterns of household formation.

Trends in household formation are a factor in the rising population of higher-density residential neighborhoods, both new and old. As last year's Annual Report noted, only about one-half the new housing units built since 1971 have been single family detached homes. In the past year a somewhat higher proportion of single family homes was built, primarily because the market for new housing was in a slump and those who could afford new houses tended to prefer single family homes. The most important factor in the shift to higher-density units is the high cost of all new housing and the difficulties of finding financing at reasonable interest rates. New single homes on their own lots are now priced out of the reach of most Americans. The cost of older housing is keeping pace. For the Washington, D.C., area, which has the highest prices for used homes in the country, the average price for such a house now exceeds the average cost of a new house.[59]

In spite of trends toward multifamily housing, cities continue to expand into rural areas and metropolitan densities continue to fall. This fact may be attributed to three phenomena. First, even the new higher-density planned communities have lower overall densities than most older urbanized areas. The new town of Columbia, Maryland, for example, averages out to 2.5 dwelling units per acre. Second, many new higher-density subdivisions, apartments, and condominiums are located on the expanding urban fringe rather than on sites within the urbanized area. Finally, a large percentage of new development continues in the form of traditional low-density subdivisions.

Table 16 shows that between 1960 and 1970 the land area of urbanized areas nationwide grew by 40 percent while population grew by 24 percent. Overall densities per square mile dropped 14 percent during the period.[60] In fact, as shown in Table 17, the land area in 82 percent of all urbanized areas is growing at a faster rate than the population.[61]

Growth Stimulants Government actions or business investment decisions that stimulate growth are important in bringing about land use changes. A power company's decision to build a new plant in a

Table 16

Population and Land Area of U.S. Urbanized Areas, 1960–70

	1960	1970	Percentage of change
Population, in millions	95.8	118.4	23.6
Area in thousands of square miles	25.0	35.1	40.4
Population per square mile	3,837	3,376	−13.7

Table 17

Changes in Land Area Compared with Changes in Population of U.S. Urbanized Areas, 1960–70

Nature of change	Urbanized areas	
	Number	Percentage
Land area increasing faster than population	175	82
Land area increasing slower than population	24	11
Land area decreasing	13	6
Land area constant	1	1
Total	213	100

Source: Derived from data reported in U.S. Bureau of the Census, *Number of Inhabitants: U.S. Summary* (Washington, D.C.: Government Printing Office, 1971), pp. 1-75 to 1-86.

small rural town has strong implications for land use in that community and the surrounding area. Pollution control measures influence where industry can locate, where major commercial services will be built, and where new housing for workers will develop. Tax policies, agricultural policies, and public lands policies can all create conditions that encourage or retard growth and powerfully influence land use. Public works projects in particular shape growth. Sometimes an impact is inadvertent, the result of improper or incomplete analysis. But often analysis is neglected because it is simply assumed that the growth-inducing effects of projects will be beneficial. Thoughtful analysis, including preparation of environmental impact statements, can help to anticipate the impacts of government regulatory programs, grants, and direct assistance and assure that growth-inducing effects are in line with community plans for development. Federal agencies, states, and localities have begun to realize the value of the EIS as a new tool to help impacted communities manage growth.

The chapter on land use in CEQ's Fifth Annual Report includes a detailed discussion of major growth stimulants—highways, mass transit facilities, sewers, energy development, air and water pollution regulation, and tax policies.

Land Use Controls At the same time that communities are learning to guide growth stimulants in conformity with development and preservation plans, they are also developing new tools to regulate land use. Traditional regulatory mechanisms like zoning and subdivision regulations are just coming into use in some rural counties. Other communities which have long used the older approaches are supplementing them with new ones. Police powers provide the legal authority for some of these novel mechanisms for land use regulation; others require acquisition of land rights from private landowners. This approach may at first appear costly, but in the long run the expense often compares favorably with the burden of community services imposed by more traditional development approaches.

The chapter on land use in the Fifth Annual Report analyzed the major land use controls—zoning (including special districts and planned unit development), review of development proposals, development rights (donations, purchase, and transfer concepts), land banking, no-growth and slow-growth policies (including growth ceilings, moratoria, and timed development approaches), preferential assessment, and use of open space purchases as a land use control. These basic controls and their variants are in constant change and reformation by communities throughout the nation.[62]

EVENTS OF THE PAST YEAR

New Patterns of Settlement

Recent analysis by the Bureau of the Census shows that since 1970, metropolitan areas have grown at a slower rate than nonmetropolitan counties.[63] This change is a remarkable contrast with past patterns, which have shown higher growth rates in urban areas almost uniformly since the first census in 1790. Although central cities had been losing population to growing suburbs for several decades, this was the first sign that metropolitan areas are now losing migrants to nonmetropolitan territory. Big metropolitan areas of more than 1 million persons account for much of the phenomenon so far. In fact, more people are moving into smaller metropolitan areas during the seventies than in the 1960's.

The causes of this new trend in migration are just now beginning to be analyzed. Industrial relocation and personal disatisfaction with life in large urban areas may be two important factors, but it is still too early to tell. To check out the possibility that the change may be explained by spillover of metropolitan area populations into adjacent rural counties, census officials subtracted out all counties with a 10 percent or higher commuting rate to metropolitan areas. The remaining nonmetropolitan territory still showed more growth than metropolitan areas or the nation as a whole. Further explanation must await additional analysis.

The implications of the slowdown for metropolitan area development are of considerable importance. Static population levels need

Since 1970, rural counties have been growing at a faster rate than metropolitan counties, a remarkable shift from previous population patterns.

not mean economic, social, or cultural stagnation; [illegible]any large and attractive European cities have experienced similar population dynamics for extended periods. For smaller metropolitan areas, the impacts are even less clear. Will they become the new growth centers now that large metropolitan areas are no longer growing at the same rate? Or is it merely a matter of time until the same phenomenon affects them?

The data show that the unexpected growth in nonmetropolitan counties is occurring in the nonfarm segment of rural areas and in small cities and towns; farm population continues to decline. Further, the pattern is not uniform. There are big increases in the Ozarks, the upper Great Lakes, the southern Appalachians, and the Rocky Mountains and continued losses in the Great Plains and parts of the Deep South.[64]

The migration of large numbers of retired people to homes in rural areas, often to seasonal homes that are converted to yearround units, may account in part for this lack of uniformity. Another factor may be the attraction of the youth culture to rural life. More studies are needed to isolate the relative importance of these and other possible causes as well as the implications of the new patterns of growth for local services and other needs of both the incoming population and the existing communities.

New Hope for Cities

The Revival of Cities as Places To Live Two years ago our Fourth Annual Report reported an emerging interest in the revival and preservation of older urban neighborhoods. This attitude was expressed forcefully by the National League of Cities at its 1974 national convention, where delegates adopted a new policy of "urban conservation," urging cities to take advantage of their existing physical resources to give a sense of history, character, and individuality to revitalization efforts.[65]

Today many downtown areas are enjoying revival, and nearly every major city has at least one neighborhood where people are using their own as well as the community's resources to upgrade and rehabilitate housing and community facilities. Often the residents are the young and relatively wealthy, although increasingly the movement is encompassing people of diverse income. There are many examples of neighborhood revival and preservation in cities:

- In Brooklyn, middle class families attracted by handsome old residential architecture, tree-lined streets, cultural and educational institutions, and easy transit to Manhattan, have been instrumental in restoring Brooklyn Heights, Cobble Hill, Boerum Hill, Park Slope, and Fort Greene. Even though banks were reluctant until recently to provide loans or mortgages, 275,000 people now live in the restored townhouses and apartment buildings of these attractive neighborhoods. The downtown shopping district along Fulton Street and Atlantic Avenue has kept its major department stores and now has the sixth largest sales volume of all U.S. central business districts. The city has assisted with the restoration of old civic buildings and has adopted special zoning regulations to encourage neighborhood renewal and preservation.
- In New Orleans, preservation battles once were fought to save the Old French Quarter from redevelopment and urban expressways. Now the Garden District, a section of fine homes and gardens, has been declared a historic area. The Lower Garden District, an increasingly popular middle class neighborhood of wood frame gingerbread houses, is also being designated for preservation, along with tree-lined St. Charles Avenue with its streetcars on the grassy median.

  The city government is also seeking to arrest the rapid demolition of 19th century Greek Revival, cast iron, and Italianate buildings in the downtown business district. One out of five buildings that existed downtown in 1970 is now gone. Development pressures in the wake of the Superdome sports arena caused construction land values to rise. In response to strong

New Orleans is an example of a city whose downtown is enjoying revival, although redevelopment spurred by the Superdome has required careful controls to preserve valuable buildings.

citizen efforts, the city declared a moratorium on demolition until regulations for new construction are established. Innovative zoning techniques are being considered to reduce pressures for demolition, encourage rehabilitation, and establish design standards for new construction to assure its compatibility with the scale and character of the older structures.

- In Seattle, a newly created Office of Urban Conservation encourages historic preservation and conservation of buildings. In recent years the city has supported restoration of the Pioneer Square Historic District. The tax base in this restored area has increased 450 percent since 1970. Employment rose from 1,500 in 1971 to 6,000, although no more than one-quarter of the buildings is occupied so far. When restoration is complete, there will be 30,000 workers in this district of refurbished 19th century commercial storefronts, warehouses used as office space, parks, shops, and night life.

  Seattle is also rehabilitating its historic Pike Place Market, where fresh fish, fruits, and vegetables attract shoppers and tourists alike to dozens of colorful stalls perched above Puget Sound. The city is taking care to retain the present tenants and character of the place while providing necessary improvements to the old wooden structures. In order to restore continuity between downtown and nearby neighborhoods, Seattle has also decided to build a fountain-filled park over the Interstate 5 freeway that slices the city.

Slated for preservation in New Orleans are tree-lined St. Charles Avenue, with its trolley lines down the median strip, and the Lower Garden District, with comfortable middle class homes.

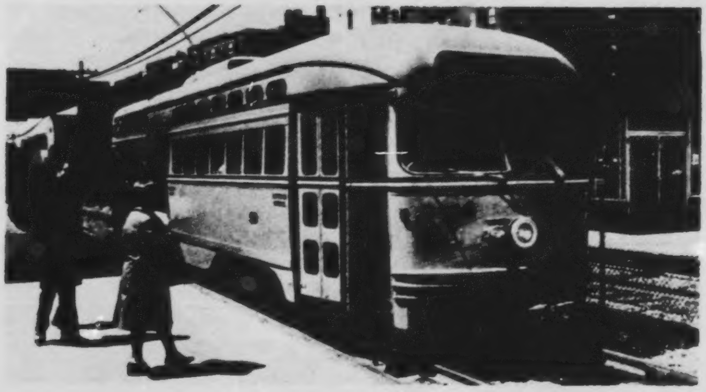
Many cities have developed new ways to assist revitalization. Pittsburgh, Savannah, Annapolis, and Charleston, South Carolina, have made extensive use of revolving funds to restore historic houses and landmarks. Under this concept, houses are bought, rehabilitated, and resold, with proceeds going back to the fund. The Historic Savannah Foundation is working to restore rowhouses and turn them back to low income tenants. Historic Annapolis, Inc., has made use of a revolving fund to purchase, restore, and use historic buildings and has set up a fund to purchase easements on the facades of old buildings in the historic district. Its $68,000 revolving fund has saved an estimated $2 million worth of irreplaceable buildings from demolition.

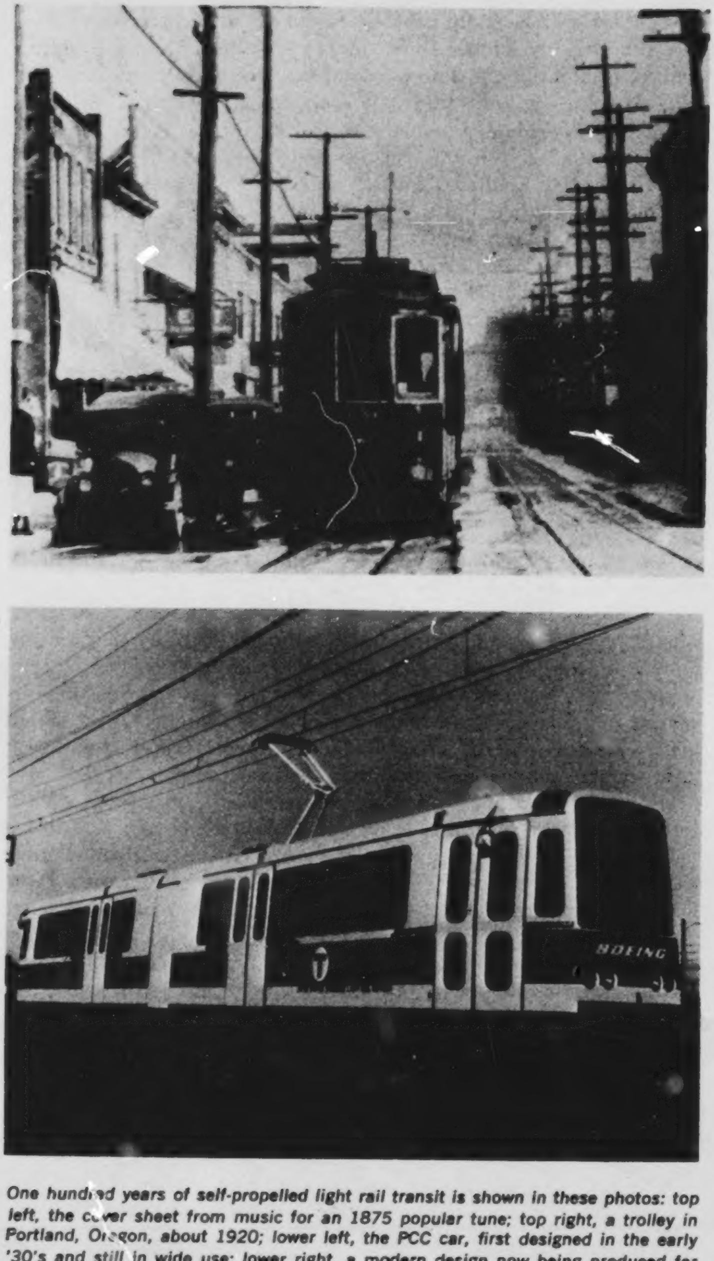
Another new approach is urban homesteading, where cities sell abandoned housing units for $1 to qualified owners who will fix them up and live in them. Homesteading is not an answer to low income housing. The money and skills required for rehabilitation are substantial—participation demands something near a middle class income. However, homesteading does provide an infusion of dollars and interest in a neighborhood that might otherwise continue to decline. Where this concept has been clearly understood, homesteading has been successful. Where it has been sought as a way to provide low income housing, it has run into trouble. Wilmington, Philadelphia, and Baltimore were among the earliest cities to start homesteading programs, and many other cities have shown interest in following suit.

Community Development Block Grants Title I of the Housing and Community Development Act of 1974 established a community development block grant program to replace narrow categorical federal assistance programs which had been used for single defined purposes, such as sewer and water projects, open space, and urban renewal.[66] Within a broad range of eligible activities, cities are free to establish their own priorities. The federal government now has far less control.

Under the new act, a clear trend may be seen for communities to spend their money on local parks, markets, streets, sidewalks—in short, on improving the neighborhoods that are already there. The trend contrasts with the older idea of demolition and clearance to start from scratch; such activities were often given priority under the federally mandated system. Large cities like San Francisco are upgrading existing residential areas and closing down such massive and controversial clearance projects as the Yerba Buena renewal project in the downtown area.[67] Such smaller cities as Reading, Pennsylvania, have also chosen to use public expenditures to reinforce neighborhood conservation efforts.[68]

Mass Transit Assistance The Mass Transportation Assistance Act of 1974 increased federal assistance for bus, rail, and other transit facilities to $11 billion over the next 6 years.[69] Perhaps even more important for cities, many of which have transit operating deficits, for the first time some of the funds may be used to subsidize operations. Federal aid was previously limited to capital improvements and





One hundred years of self-propelled light rail transit is shown in these photos: top left, the cover sheet from music for an 1875 popular tune; top right, a trolley in Portland, Oregon, about 1920; lower left, the PCC car, first designed in the early '30's and still in wide use; lower right, a modern design now being produced for a number of U.S. cities.

the purchase of new equipment. Operated by the Urban Mass Transit Administration of the Department of Transportation, program funds offer cities the flexibility to find new solutions to auto congestion, air pollution, and center city economic stagnation.

Mass transit innovation sometimes means a revival of transportation systems that failed to survive the competition of the private automobile. In Dayton, Rochester, New York, San Francisco, Boston, and Philadelphia, new equipment is being added to old trolley systems. These new vehicles mark the first major improvement in the style, safety, and comfort of light rail transportation since the old PCC car, built between 1934 and 1952.[70] Several cities now use exclusive bus lanes and busways and are studying other novel transit approaches. In some cities rail commuter systems can be put into service or expanded. The new funding for mass transit helps make such projects feasible.

Flexibility in Highway Assistance When the Federal Aid Highway Act[71] was passed in 1956, cities wanted as many freeways as they could get. Twenty years' experience has brought a skepticism about the value of new urban freeways in most cities. The direct impacts of these projects on housing, parks, neighborhoods, and tax bases have caused serious difficulties in many communities. And the difficulties have been compounded by less direct effects—reduced viability of the center city as a place to work and live, relocation of industry and wholesaling to urban fringe freeways, and reinforcement of the pattern of auto dependency, with its air pollution and high energy consumption. Because nearly every major U.S. city has become embroiled in debate over new freeways, the 1973 Highway Act allows highway funds to be transferred to transit projects, both from interstate segments and from other urban highway projects.

Complex regulations and disagreement among jurisdictions have inhibited transfer of interstate highway funds to mass transit. So far only Boston, Philadelphia, and Washington have substituted mass transit for interstate highway projects. Atlanta, Seattle, and Portland, Oregon, have yet to reach agreement with their Governors; nor has the Federal Highway Administration formally approved the withdrawals. The Governors of Illinois and Colorado no longer want certain interstate segments but some Chicago and Denver jurisdictions do. One cause of reluctance to withdraw interstate projects is that the local share of 10 percent for the interstate highway rises to 20 percent for transit projects. Another is that transit projects and interstate highways are an either-or proposition. Under the 1973 law, it is not possible to substitute a combination package of mass transit and attractive parkway for an interstate-standard freeway.

New highway legislation proposed by the Administration in 1975 would make the substitution possibilities more flexible and thus more attractive to cities.[72] The legislation would also give priority within the interstate system to segments necessary to connect existing parts of the system. In many urban areas, beltways and other roads already connect interstate routes. The effect of this priority would therefore be to focus funding on incomplete sections of interstate highways in rural areas. Urban freeways would be funded only when a case-by-case determination showed them to be the best solution to metropolitan transportation needs.

New York and East St. Louis, Illinois, are the only cities that have successfully transferred non-interstate federal urban highway funds from highway projects to transit projects. Sometimes state transportation officials who must approve the transfers are highway oriented and discourage applications. Further, the federal government provides only 70 percent of the funds in this noninterstate program. Hard-pressed localities must come up with 30 percent of the money if they use this source of funding for mass transit. If they use transfers from interstate funds, their share is only 20 percent. Likewise, their share is 20 percent if they receive funds under the new Mass Transportation Assistance Act.

Local matching funds for highway building usually come from the state gasoline tax, but this source cannot generally be used for the local share for mass transit. As a result, many communities find it difficult to use the transfer provisions of the 1973 Highway Act to substitute transit projects for unwanted highways. Provisions to correct these disincentives are among the amendments to the Highway Act which the Congress is considering.[73]

Federal Buildings in Cities The federal government owns 400,000 buildings and leases many more. Most of the square footage is office space in downtown areas. Currently about $1 billion dollars is spent each year on the construction of new federally owned buildings. Nearly always priority is given to the lease or construction of new buildings over the purchase and renovation of older buildings. New federal buildings often cause unnecessary demolition and clearance of existing structures in downtown areas. The new buildings are seldom

A growing number of cities have begun to follow the lead of Boston, which has routed Interstate 95 around the city on an existing beltway, from which access to the city is possible by transit and by using radials and expressways that are already there.

of architectural distinction, and the statutory ban on any mix of commercial, educational, and cultural uses within federally owned office buildings frequently results in a stark structure standing apart from its environment and remaining empty except during office hours.[74]

Legislation under consideration by the Congress would encourage federal purchase and adaptive use of older buildings for office space and would allow a mix of uses within and around federal buildings.[75] This approach would make the federal presence in a city one that adds to urban vitality. One successful example is the state of Missouri's recent purchase of the valuable old Wainwright Building, a registered national landmark, built by Sullivan and Adler. It will be restored and used as government office space. In Nashville, the state is putting up an office building that will house music and dramatic theaters, studios, and a museum on the first five floors. Other countries, such as Canada and Sweden, have successfully located many commercial and community facilities in government buildings.

Understanding Urbanization

Both the Fifth Annual Report of the Council and the 1974 report on *National Growth and Development* of the Domestic Council looked at how government actions can affect growth in general and the process of urbanization in particular. Many major public facilities such as highways and sewers are especially significant growth stimulants. In addition, through government regulation of privately financed facilities like refineries and powerplants, the public has a hand in shaping the growth that they bring. In the past year, there were several developments that improve our understanding about these growth stimulants.

Sewers In September 1974, CEQ released a study of 52 interceptor sewers on the urban fringe that had been funded by the Environmental Protection Agency waste water treatment grants program.[76] The study showed that current practices used to estimate capacity and determine routing of interceptor sewers resulted in extension of sewer service to large areas of vacant land. The practice adds significantly to development pressures. Further, installation of full capacity all at one time opens large areas to wholesale development and encourages urban sprawl.

The key question is how to design projects that meet water quality goals and yet do not create undue urbanization pressures. Greater attention is being given to staging the size and extension of interceptors to keep them more in line with community growth management goals. As discussed in the section on water quality earlier in this chapter, these issues have been the subject of public hearings in anticipation of amendments to the Federal Water Pollution Control Act.

In the past year, the growth-inducing effects of sewers have become major issues for public debate.

- On Block Island, Rhode Island, townspeople and owners of summer homes expressed concern about the degree of new high-density development that sewer service to the New Harbor area would induce.[77]
- In Valley Forge, Pennsylvania, citizens developed local land use regulatory mechanisms that they hoped would be adequate to control development pressures likely to arise from excess sewer capacity.[78]
- In the Three Lakes region of Colorado, the problem was deciding whether to sewer areas around the lakeshore, thus possibly inducing denser development and resultant pollution from runoff. The alternative was to continue to rely on septic tanks for scattered low density development and hope that they remained adequate for anticipated development.[79]
- In the Green River Valley near Seattle, the issue was how much excess capacity to include in an interceptor sewer running down the valley, given area land use plans that included preservation zones near the proposed sewer route.[80]

Air Quality Programs During the past year, the Congress has given increasing attention to several aspects of Clean Air Act implementation which may have land use impacts. A number of these were discussed in detail in the chapter on land use in our Fifth Annual Report. The current state of Congressional review and action

The Green River Valley near Seattle has been a center of controversy over the growth-inducing effects of a major new sewer line.

in such key issues as parking management, indirect source review, and significant deterioration regulations is discussed in the air section of this chapter.

The Congress has been particularly concerned over efforts to manage parking. The legislative history of both the 1974 Amendments to the Clean Air Act and the EPA appropriation bill for 1975 made it clear that the Congress intends primary control over such facilities to lie with local governments.[81] Congressional concern was a major factor in EPA's decision to postpone indefinitely a program to regulate indirect air pollution sources—that is, major new facilities like shopping centers and stadiums that rely on auto transportation. An EPA study of how regulation of indirect sources would affect the location of shopping centers found that the most difficult siting problems would be in already heavily urbanized areas.[82] Indirect source regulation might have created incentives for dispersion that could have run counter to local growth management plans.

Significant deterioration regulations, which would establish a state program to identify the areas that can and cannot accept higher levels of air pollution, are also closely tied to land use issues. Under the EPA-proposed system, three classes of zones would permit varying amounts of pollution up to national ambient standards. These designations could affect location of industries. Under one of the alternatives considered by the Senate, the class permitting the highest pollution level would be eliminated. This approach might mean that new industry would have to disperse, not necessarily the best solution from a land use perspective.

Energy Development Any new industry in a community is important because of its economic and environmental effects. Aside from the direct effects of employment, tax revenue, pollution, and land use, industry can create many other changes in the community. To the extent that the construction and permanent work forces come from outside, they will also require housing, commercial facilities, and a range of services. Further, one industry often attracts another industry, either to supply it or to use its products.

Interest in estimates of the full range of community impacts from new industrial development has grown in the past year, primarily because of proposals for new energy-related development. Outer continental shelf oil and gas and Western states' coal are the largest-scale developments likely. The unexpected severity of pipeline impact on Alaska communities has intensified interest in full discussion of the possible effects of OCS and western coal development before either begins.

CEQ has published a report on the secondary impacts of OCS development,[83] many of which involve significant changes in land use patterns, especially in smaller coastal communities. Similar work has been done with respect to coal development in the Northern Great Plains,[84] and more studies are underway by CEQ and others.

The impacts of OCS development are discussed further in the previous section on the coastal zone.[85]

Concern about Agricultural Land

The loss of agricultural land in the United States has long been a subject of concern, especially the conversion of prime croplands in expanding urban areas. During the past year the subject has received a great deal of new attention.[86] Latest estimates from the Economic Research Service of the Department of Agriculture indicate a net annual loss of cropland at about 1.25 million acres. This represents an overall shift of 2.5 million acres out of cropland each year, offset in part by the addition of 1.25 million acres of new cropland.

Contrary to general impression, only 10 percent or 250,000 of the lost acres of cropland is removed by urban development. Rural transportation—primarily new roads—takes 35.000 acres of cropland each year, and new reservoirs cover about 50,000 acres. The remaining acreage, some 2.2 million acres, or 87 percent of the total, is land reverting to grazing and forest. Much of this land is in the Northeastern and Southeastern states where contours and soil conditions make farming with modern equipment difficult.[87] Although these numbers may not appear significant in relation to the 470 million acres of U.S. land that is suitable for crops, cropland abandonment is concentrated enough in some areas to cause economic and social problems.

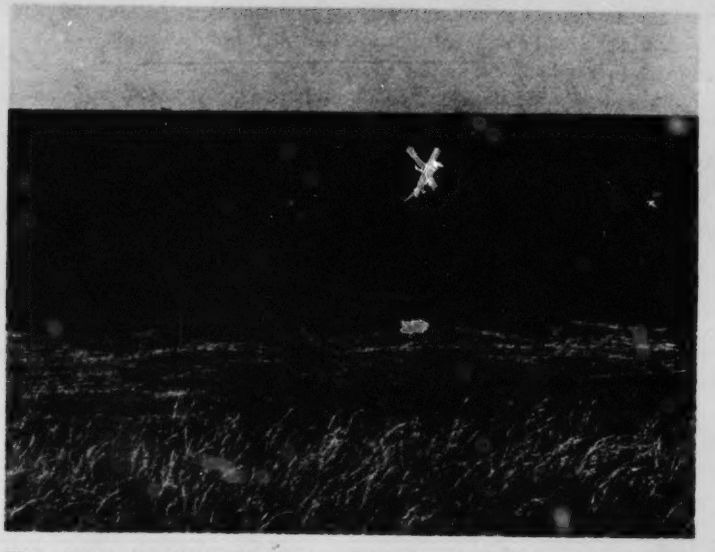
Much of the abandoned farmland is marginal from the point of view of productivity, but new farmland may be marginal from an environmental standpoint. Some 400,000 acres of cropland added each year is irrigated land dependent on dammed or diverted water or deep wells. In time, energy development in the Northern Great Plains and other water-scarce western areas may place competing demands on the water that this cropland requires. Other new cropland is created from coastal wetlands and inland wetland "potholes" that serve important functions for fish and wildlife populations. Draining of wetlands for new cropland continues to destroy these important biological resources, especially in Florida and the upper Midwest. Finally, bringing new cropland into production requires extensive use of commercial fertilizers, as do continued increases in productivity of land already under cultivation. In addition to water quality problems created by fertilizer runoff into streams, there are other important implications of continued dependency on commercial fertilizer, including resource problems because fertilizer is made of natural gas or petroleum.

While net losses in land suitable for crops continue, the acreage under cultivation has risen sharply in the past 3 years. For a decade or more, only about 330 million acres of the 470 million acres suitable for crops was planted each year. The remainder was used for forage crops, or it lay fallow in compliance with government programs to restrict production. Beginning in 1973, however, the combination of increased demand for U.S. food on the world market, increasing domestic food prices, and a phaseout of agricultural programs that limited food production brought a significant increase in cropland acreage used for crops. By 1975, an estimated 362 million acres was under cultivation, the highest since the early 1950's, when productivity per acre was considerably lower.[88]

There is some concern that much of this new acreage is marginal, better kept in pasture or forage because it is susceptible to erosion, dust storms, and other natural forces that cause rapid soil depletion. A recent report to the U.S. Senate examines these issues and concludes that although soil conservation measures are necessary in many new areas, a new dust bowl is unlikely.[89] Nevertheless, the trend toward putting more land into production each year while reducing the overall supply of land suitable for crops bears close watch. There is still a considerable gap between the 362 million acres in production and the 470 million acres capable of growing crops, but the gap is slowly closing, and the acreage that remains in reserve is by no means our most productive land. Nearly all of that is already in production.

An immediate concern is the localized impacts of farmland loss. In some areas the conversion of working farms to urban uses or to natural pasture has been so extensive as to threaten the existence of farm support businesses and other institutions necessary for continued farming. New Jersey, for example, has undertaken major planning studies to preserve the remaining agricultural land in the face of urban encroachment.[90] Vermont studies have shown a disturbing tendency for farms to be sold to new owners who take them out of production, sometimes converting them into seasonal homes.[91] In other areas, specialty croplands, such as artichoke fields and prune orchards in California, have been lost.

In response to pressures to preserve agricultural lands, especially near expanding urban areas, 42 states have enacted some form of differential property tax assesment law.[92] Usually these laws allow the local assessor to value land in farm or other open use at present use value for property tax purposes, excluding the potential for urbanization or other high value uses from the calculation. The mechanics and variations in differential assessment laws are discussed in the chapter on land use in last year's Annual Report. In addition, CEQ has contracted a study of differential assessment laws by the University of Pennsylvania. Preliminary results indicate that although such laws often reduce the cost of continued farming, they do little more than delay for a few years the time that the farms would otherwise go out of production. This delay may be of value to localities seeking a variety of growth controls, but differential assessment itself is not likely to affect long-term preservation of agricultural uses. A further description of the study is included in Chapter 7. More advanced techniques for preservation are being tried in some localities, as the next section discusses.



These photos show the natural grass prairie in Illinois in 1915 and the way it looks today as fertile cropland. There is growing concern over the need for policies to protect our productive farmlands.

Experience with Management Techniques

A number of steps toward improved land use management techniques have been taken at federal, state and local levels in the past year.

Coordinating Federal Planning Assistance Following a discussion at a Cabinet meeting in December 1974, the President ordered the Department of Housing and Urban Development to undertake a major initiative to coordinate the nearly three dozen separate federal planning assistance programs.

Agreements have now been signed to coordinate funding and planning requirements among HUD's own 701 comprehensive planning program, the Coastal Zone Management Program in the Department of Commerce, and the section 208 areawide water planning program of the Environmental Protection Agency.[93] These three account for nearly one-half of some $550 million in federal planning assistance available last year to states and localities. The effort is particularly timely because of the new requirement in the HUD 701 program for a land use element as part of comprehensive plans by August 1977.[94] This element must provide for coordination with other planning in the community. Efforts are underway to expand the agreements to include other federal planning programs, especially those funded by the Department of Transportation.

State Land Use Programs Since last year's Annual Report, Wyoming has become the ninth state to enact comprehensive land use legislation.[95] Proposed energy development apparently spurred the Wyoming legislation; it has certainly influenced other states to enact coastal zone and energy siting laws. On the other hand, the Vermont Legislature balked at enacting the final step of Law 250, which would have created additional statewide regulatory powers. And the Alaska Legislature turned down the Governor's proposed bill for comprehensive coastal zone management. The status of state land use laws as of April 1975 is shown in Table 18.

The American Law Institute's Model Land Development Code,[96] which has been the model for proposed federal land use legislation as well as state laws, was adopted by ALI at its May 19–20 conference. The code includes model statutes on formation of state agencies, state and local review procedures, enforcement, and land banking. Its official adoption is expected to aid in restructuring state and local land use authorities.

Florida's comprehensive and controversial land use law, enacted in 1972,[97] was invoked during the past year to designate two areas as environmentally critical. The law limits this designation to 5 percent of the state land area. A portion of the Green Swamp was the first to be labeled a critical area. Far more controversial was the decision in April to designate the Keys. In June, Monroe County was given 6 months to develop a land use plan and adopt regulations under state guidelines; meanwhile, the cabinet authorized the state Division of Planning to impose temporary regulations. Until the county plan is ready, the area will remain under direct state regulation.[98]

Trying Out Advanced Techniques In August 1975, the Ninth U.S. Circuit Court of Appeals in San Francisco handed down its long-awaited decision on Petaluma, California's controversial growth control ordinance. The Petaluma plan limited to 500 the number of subdivision houses built each year; the limit did not apply to single homes or groups of fewer than five. It was enacted in 1972 after the city had experienced a 25 percent population increase in 2 years, primarily due to expansion of the San Francisco metropolitan area. Developers challenged the statute successfully in U.S. District Court, which held, among other things, that by unduly restricting the opportunities to settle in Petaluma, the statute violated the constitutional right to travel.[99] Critics also argued that the ordinance was in effect an economic and racial barrier.

The Court of Appeals reversed the lower court and upheld the right of the city to enact and enforce its slow-growth ordinance. The court drew an important distinction between the Petaluma plan and ordinances that it might find discriminatory, saying that the city's approach did not wall out any particular income class or racial minority. The court declared: "[T]he concept of the public welfare is sufficiently broad to uphold Petaluma's desire to preserve its small town character, its open spaces, and low density of population and to grow at an orderly and deliberate pace." [100]

The Petaluma decision reinforces other recent decisions upholding managed growth and timed development ordinances and overrules the "freedom to travel" argument developed by the lower court.[101] These concepts are discussed further in the chapter on land use in the Fifth Annual Report. The Petaluma opinion contrasts, however, with recent decisions by Virginia state courts holding illegal a series of growth control measures taken by Fairfax County, a suburban county in the Washington, D.C., metropolitan area. And the Petaluma decision may be appealed to the Supreme Court for final resolution of the issues.

A number of communities are moving ahead with a combined program of land use designation and compensation for the rights taken. Boulder, Colorado, continued its open space acquisition program by picking up the development rights on several parcels. One group of properties comprised 172 acres; the average development rights price of $1,560 per acre was considered 30 to 60 percent of the full land cost. Carefully controlled development will be allowed on some parcels, and public access easements will cross other areas.[102]

Even more ambitious is the program of Suffolk County, New York, to purchase development rights to 13,000 acres of farmland for $60 million.[103] This is 20 percent of the remaining open farmland in the rapidly urbanizing county. Through a unique arrangement, farmers were asked to offer options to the county for it to buy the development rights to all or part of their land. An educational campaign

Table 18

Status of State Land Use Legislation, April 1975

State	Enabling legislation				Functional programs								
	Municipalities	Counties	Regional agency advisory only	Regional agency review authority	Procedures for coordination of functional programs	Land use-value tax assessment law	Surface mining	Flood plain regulations	Power-plant siting	Wetlands management	Critical areas	Coastal zone[1] management program participation	State land use program[2]
Alabama	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	Yes	1
Alaska	Yes	Yes	N/A	N/A	Yes	Yes	Yes	No	Yes	No	No	Yes	2
Arizona	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	No	No	N/A	2
Arkansas	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	N/A	2
California	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	2
Colorado	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	N/A	3a–c
Connecticut	Yes	N/A	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	2
Delaware	Yes	No	Yes	No	Yes	Yes	No	No	No	Yes	No	Yes	2
Florida	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	3a–e
Georgia	Yes	Yes	Yes	No	Yes	No	Yes	No	No	Yes	No	Yes	2
Hawaii	No	Yes	N/A	N/A	Yes	Yes	No	Yes	No	No	No	Yes	3a–e
Idaho	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	N/A	2
Illinois	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	No	Yes	2
Indiana	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	Yes	2
Iowa	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No	No	N/A	2
Kansas	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	N/A	2
Kentucky	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	No	No	N/A	2
Louisiana	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	No	Yes	2
Maine	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2
Maryland	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	3a–c
Massachusetts	Yes	Yes	Yes[3]	No	No	Yes	No	No	Yes	Yes	No	Yes	2
Michigan	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	Yes	2
Minnesota	Yes	Yes	Yes[4]	No	No	Yes	No	No	Yes	Yes	Yes	Yes	2
Mississippi	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	2
Missouri	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	N/A	2

Montana	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	N/A	2
Nebraska	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	No	No	N/A	2
Nevada	Yes	Yes	Yes	No	Yes	Yes[5]	No	No	Yes	No	Yes	N/A	3a–c
New Hampshire	Yes	Yes	Yes	No	No	Yes	No	No	Yes	Yes	No	Yes	2
New Jersey	Yes	No	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	2
New Mexico	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	N/A	2
New York	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	2
North Carolina	Yes	Yes	Yes	No	No	No	Yes	Yes	No	Yes	Yes	Yes	3a–c
North Dakota	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	No	N/A	2
Ohio	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	No	No	Yes	2
Oklahoma	Yes	No	Yes	No	No	No	Yes	Yes	No	No	No	N/A	2
Oregon	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	No	Yes	Yes	3a–c
Pennsylvania	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	Yes	2
Rhode Island	Yes	N/A	No	No	Yes	Yes	No	No	Yes[6]	Yes	No	Yes	2
South Carolina	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	Yes	2
South Dakota	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	No	N/A	2
Tennessee	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes[7]	No	No	N/A	2
Texas	Yes	No	Yes	No	Yes	Yes	No	No	No	Yes	No	Yes	2
Utah	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	Yes	N/A	2
Vermont	Yes	N/A	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	N/A	3a–e
Virginia	Yes	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	2
Washington	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	2
West Virginia	Yes	No	Yes	No	Yes	No	Yes	Yes	No	No	Yes	N/A	2
Wisconsin	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	2
Wyoming	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	No	N/A	3a–d

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[1] No state has an approved coastal zone management program at present.

[2] State land use program code
1. No activity at state level
2. Study (executive or legislative) or state legislative consideration in progress
3. State land use program legislation enacted
   Authorization for:
   (a) inventorying existing land resources, data and information collection
   (b) policy study or promulgation by agency or commission
   (c) identification of land areas or uses of more than local concern
   (d) regulation or management of land areas and uses identified
   (e) direct state implementation or state review of local government implementation.

[3] Areawide Council for Martha's Vineyard has authority to administer controls.

[4] Twin Cities Metropolitan Council has regulatory authority.

[5] Must be ratified in a referendum to take effect.

[6] In the coastal zone a development permit from the Coastal Council is required.

[7] Powerplant siting is conducted by TVA only.

Source: U.S. Department of the Interior, Office of Land Use and Water Planning.

familiarized farmers with the development rights approach, property tax benefits, and other elements of the program, and the program was billed as the only effective way to save the farmland for the farmers. The farmers' response was enthusiastic—381 landowners offered 17,800 acres of development rights for a total of $117 million. This gave county planners a choice of properties and prices and allowed them to piece together large contiguous areas for preservation. While bonding issues remain to be worked out, the prospects are good for exercising the options in the near future.

Successes like these have given impetus to other programs to preserve open lands through the purchase of development rights, easements, and other rights in land. Both the Connecticut and New Jersey Legislatures gave serious consideration in recent sessions to such proposals. In Connecticut, the bill would have set up a state commission to buy development rights of at least 70 percent of the state's remaining 500,000 acres of farmland. It ran into trouble because of the Legislature's reluctance to impose a real estate tax to finance the program.

ISSUES TO WATCH FOR

The foregoing discussion has touched upon several emerging and unresolved issues. Among them are the significance of the new census reports which show a flattening of growth in large metropolitan areas and a faster-than-average rate of growth in nonmetropolitan counties that reverses previous patterns. Another emerging issue concerns the supply of agricultural land and the shifts in the use of land to and from agricultural categories. Several other land use issues are likely to draw increasing attention in coming months.

Growth Control and Housing Opportunity

Recent decisions indicate a growing debate in the courts over restrictive residential zoning practices of suburban communities. Large minimum acreage requirements, minimum housing sizes, and setback requirements are traditional land use controls in many suburbs. Although they provide continuity and security that the community wants, they also make housing costly. Increasingly, courts are allowing citizens from outside the community to challenge such ordinances as unconstitutionally discriminatory.

Cases from Penfield, New York, outside Rochester, Mount Laurel, New Jersey, near Camden, and Petaluma have highlighted the issues. The U.S. Supreme Court held in the Penfield case that a plaintiff must show actual personal harm to establish standing,[104] but it left open the legality of land use controls once such standing is established. The Supreme Court has agreed to review a Chicago case which may provide more guidance on the merits of traditional suburban land use practice.[105] By way of contrast with Petaluma, the New Jersey Supreme Court found in the Mount Laurel case a pattern of exclusionary effect. The court outlawed land use practices that prevent a community from meeting its fair share of the regional need for a range of housing to suit different incomes.[108]

The New Jersey decision tackled one of the major emerging issues in land use in suburbia. In the past fair housing advocates have tended to label as exclusionary all land use controls in the suburbs, including modern growth control strategies. At the same time, advocates of strong land use controls have seldom considered the effect of growth management on housing costs.

The goals of the two parties may in fact be similar. Advanced growth management strategies reject the traditional zoning techniques that fair housing advocates attack. Clustering of dwelling units, timed development ordinances, higher residential densities all are new approaches that are suitable both for managed growth and for lower-cost housing for buyers and renters. These approaches can also provide more varied housing. As the Court of Appeals in the Petaluma case pointed out, growth control does not necessarily imply exclusion of economic or racial classes. Hostility between these two forces for change is not inevitable. Once recognized, common interests between the two could produce both sensitive growth management and a wider range of affordable housing opportunities.

The Aging Suburbs

The older suburbs that grew up around our cities after World War II are now nearly 30 years old. Central cities have received some attention, but outside aid has almost entirely neglected these aging suburbs. Often they are comprised of stable neighborhoods, stores, and places of employment that need little assistance. Some have benefited from the energy crisis, which impressed on commuters the value of living near their jobs or near mass transit.

Nonetheless, there is cause for concern about the long-term viability of these areas. Older shopping centers and commercial strips have lost business to modern, large-scale outlying centers. Many stores have closed. Even the office buildings that many downtowns rely upon to produce taxes are often lacking, and local government may face major fiscal problems. Elsewhere the pressures for urbanization have brought about redevelopment, with expensive apartment houses and condominiums replacing more affordable residential neighborhoods of single family homes. New freeways, often built to carry commuters from more distant suburbs to the downtown business district, slice through these areas, providing little economic benefit to offset adverse effects.

There is no reason to assume that these areas cannot grow old gracefully. But it will require planning to avoid the extremes of decay and uncontrolled redevelopment. The economic and fiscal pressures on these communities, plus the fact that some were not well-designed or well-supplied with public services when they were built, make the coming years critical for them. Some will undergo higher-density redevelopment, others will settle in as stable residential communities, but some are likely to become future problem areas in urban America.

Coordination of Land Use with Other Policies

Efforts to develop and implement land use and growth strategies in metropolitan areas prove once again that everything is related to everything else. For example, less use of automobiles, better mass transit, and more compact communities would all conserve energy.

These interdependencies are gaining recognition. *The Costs of Sprawl* report[107] is an example, as is a CEQ followup study on energy use.[108] The Environmental Protection Agency and its state counterparts are increasingly concerned with how land use controls affect air and water pollution goals and with how sewers, air and water permits for new factories, and air pollution controls on parking lot locations in turn can affect land use. The Department of Transportation and its state, regional, and local counterparts have begun to consider multimodal factors in selecting transportation modes, including impacts on development patterns, air pollution reduction goals, and energy conservation efforts. The effort is just beginning. It promises to attract more and more effort and public attention.

WATER RESOURCES

BACKGROUND

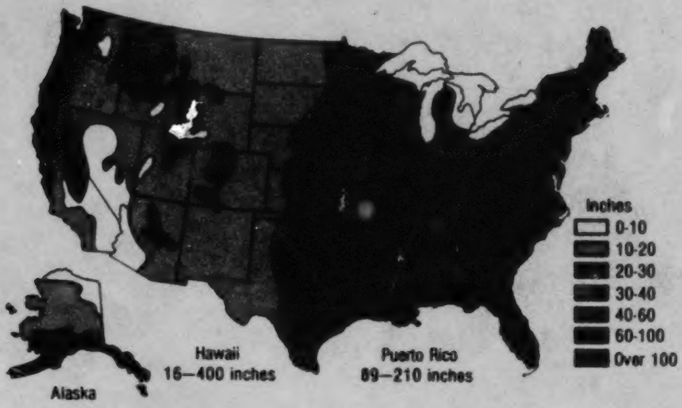
Each day, on the average, rain and snowfall distribute more than 4.2 trillion gallons of precipitation across the coterminous United States.[109] If it were distributed evenly, the average annual precipitation would be 30 inches nationwide, but there are great variations from one region to another, as shown in Figure 10. About 70 percent of this water returns to the atmosphere through direct evaporation and through the transpiration processes of vegetation. The rest of this water percolates into the soil or runs off the surface into streams, lakes, and rivers, where it eventually flows into coastal estuaries, mixing with seawater. Solar radiation then causes evaporation from the ocean to the atmosphere, continuing the water cycle.

Throughout history the distribution of fresh water has largely determined the distribution of human populations. European immigrants to North America settled in or near productive river valleys, as had the Indians before them. These rivers and inland lakes provided food, agricultural and domestic water supplies, important transportation routes for commerce, and opportunities for recreation as well.

It is therefore not surprising that one of the earliest concerns of the federal government following independence was water resources

Figure 10

Average Annual Precipitation



Source: U.S. Water Resources Council, *The Nation's Water Resources* (Washington, D.C.: Government Printing Office, 1968), Figure 3-2-1.

planning and development. The first federal planning and construction efforts were for navigation improvements; gradually the federal role was expanded to include programs for irrigation, flood control, power generation, recreation, fish and wildlife protection, and water quality improvement. These programs are selectively reviewed briefly below.

Navigation

In her history of federal water resources programs,[110] Beatrice Holmes points out that rivers were a principal means of westward expansion in the early 19th century, providing "interstate highways" for the movement of people and materials. A political dispute over the extent of federal authority was resolved in 1824 by the Supreme Court, which ruled in *Gibbon* v. *Ogden* that Congressional power over navigation extended "within the limits of every state in the Union so far as that navigation may be in any manner connected with the commerce . . . ." [111] That same year the Congress passed a General Survey Act authorizing the President to employ officers of the Corps of Engineers and others in planning roads and canals of national importance. This act and the first omnibus Rivers and Harbors Act in 1826 established the navigation improvements program of the U.S. Army's Corps of Engineers. Later legislation gave the Corps regulatory responsibility over construction by others of bridges, piers, channels, and harbors and in 1899 over the deposit of refuse and other

The C&O Canal was privately built for commercial use in the 19th century along the Potomac River between Washington, D.C., and Cumberland, Md. The canal was later abandoned but is now being partly restored by the National Park Service for recreational uses. Here are shown Lock #5 circa 1900 and the canal near Lock #20 today.

materials in navigable waters. This authority was invoked in the late 1960's to control water pollution until passage of the 1972 Water Pollution Control Act Amendments (see the section on water quality early in this chapter).

Following World War I, the Corps was authorized to expand its planning functions to conduct comprehensive surveys of river basins and to develop general plans for "navigation improvement in combination with developments for power, flood control, and irrigation." [112] While expanding Corps authority, the Congress maintained and strengthened its own authority over individual Corps projects and activities through the authorization and appropriation process, resisting executive branch attempts to consolidate federal water resources planning and development. Congress also reaffirmed longstanding federal policy that shippers and other users of the navigable waters of the United States could not be charged tolls for passing through navigation facilities built on these waters.

Flood Control

Although repeated flooding of the lower Mississippi and the Sacramento Rivers attracted national attention in the 19th century, it was not until passage of the Flood Control Act of 1917 that the Congress gave the Corps of Engineers responsibility for planning and constructing flood control works (not to include reservoir projects) on these rivers.

The worst flood in the nation's history occurred on the Mississippi River in 1927, inundating 25,000 square miles and causing over $230 million in property damage and the loss of at least 300 lives. The next year the Congress authorized the initial development of a gigantic federally funded flood control project for the Mississippi River and its tributaries, a project that is still being constructed today.

With the coming of the depression and the New Deal era, federal planners sought ways to provide employment and economic growth. Many multipurpose public works projects were undertaken, combining flood control (based on earlier Corps surveys) with power production, irrigation, and other purposes. The Tennessee Valley Authority was created in 1933 with broad responsibilities for planning and construction of dams and reservoirs for these purposes, including the generation and sale of electric power in the region of the Tennessee River basin.

Federal flood control efforts were local or regional until the Flood Control Act of 1936 "inaugurated a national flood control program and assigned jurisdiction over federal flood control investigations and improvements to the Corps." [113] This act and subsequent legislation also authorized the Department of Agriculture to investigate and plan improvements in the watersheds of major national waterways.

Coupled with the greatly expanded federal role in planning and financing water resources development during this period was an effort by the executive branch to exert a more effective coordinating and planning role, which culminated in creation of the National Resources Planning Board in 1939 within the Executive Office of the President. The NRPB brought together the Departments of War, Interior, and Agriculture to coordinate river basin planning and to seek greater consistency and specificity in agency methods of estimating project benefits and costs as required by the 1936 Flood Control Act.[114]

Such efforts encountered long-standing Congressional resistance and were viewed by some Members of Congress as a usurpation of their traditional powers. In 1943, Congress abolished the NRPB; in the next decade flood control and other water resource development "became increasingly the exclusive concern of the congressional committees responsible for agency-enabling legislation and appropriations." [115] The Corps of Engineers flood control activities were greatly expanded; the Corps was authorized to construct facilities providing for municipal and industrial water supplies.

The Soil Conservation Service, established in 1935 within the Department of Agriculture, was given the responsibility for conducting a national cooperative program for soil and water conservation. Initial SCS efforts to reduce soil erosion and retain surface runoff for agricultural purposes produced watershed management plans for the upper portions of major river basins. At first these plans were limited to improved agricultural land treatment and other nonstructural measures; however, increasing concern over agricultural losses from flood damage led the Congress in 1951 to approve SCS involvement in limited reservoir construction, channel improvement, and other structural measures.

In 1954, in response to widespread constituent interests, the Congress passed Public Law 566, which authorized SCS to conduct a nationwide program for flood prevention and other improvements in watersheds of less than 250,000 acres.

Irrigation

Despite the Homestead Act of 1862 and other federal incentives, settlement of parts of the West during the 19th century was limited by availability of water. A survey of arid western lands published in 1879 by the U.S. Geological Survey led to the establishment of an irrigation division within that agency and federal encouragement of state and local irrigation efforts through land sales and transfers.

Then, in the Reclamation Act of 1902, the Congress established a Reclamation Service in the Geological Survey and authorized the Secretary of the Interior to use funds from the sale of public lands in the 16 Western states to conduct surveys and to construct irrigation works there. By 1907 Congress had separated the Reclamation Service from the Geological Survey and had authorized the Secretary of the Interior to combine irrigation with water power development and the sale of power (and later, excess water) to towns and other nonfarm users. Texas had been added to the list of states covered by the program, making a total of 17 states.

In 1923 the Reclamation Service was renamed the Bureau of Reclamation. At that time federal interest in irrigation centered on the Colorado River basin as a potential water source for California's Imperial Valley. The Boulder Canyon Project was authorized in 1928 to include a canal, reservoir, and dam for improved flood control, navigation, irrigation, and municipal water supplies. Power generation was also included specifically to provide revenues to offset construction and maintenance costs. Congress further directed Interior to undertake project feasibility studies elsewhere in the basin to support a comprehensive water resource development program for the Colorado River system.

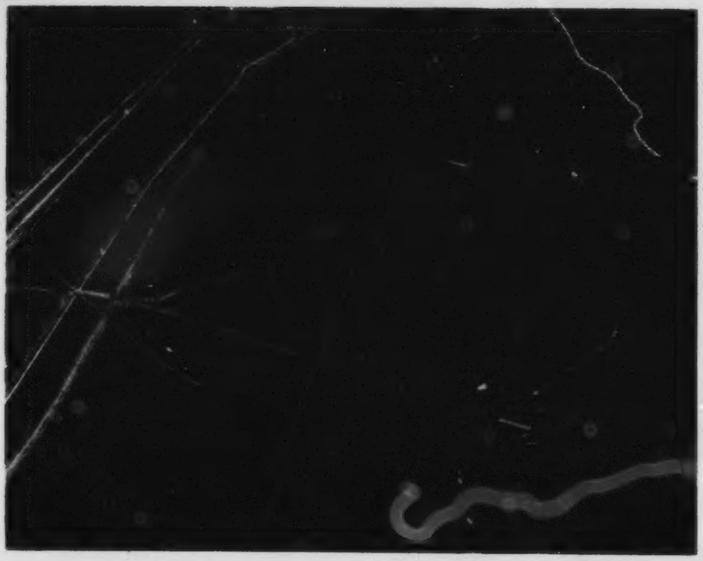
The unfortunate combination of a nationwide depression and widespread droughts in the early thirties hit midwestern farmers especially hard. The spread of the "dust bowl," as well as the need for coordinated programs to stimulate economic recovery, led the Congress and the New Deal planners to create the Public Works Administration (PWA) in 1933 as part of the National Industrial Recovery Act. This act also provided emergency authorizations and appropriations for public works, including irrigation projects of the Bureau of Reclamation. By 1940 the bureau was also authorized to construct multipurpose projects (providing for irrigation, navigation, power generation, and water supply) and to assume throughout the arid West a greater share of construction costs, recovering these costs through the sale of electric power. In 1944 Congress authorized the bureau's role in developing the huge Pick–Sloan Missouri Basin plan in association with the Corps of Engineers.

Water Power

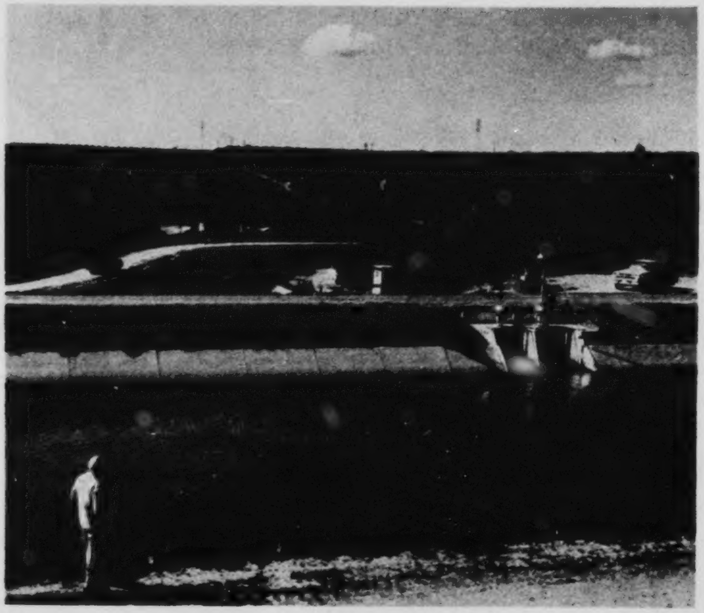
The use of power revenues to repay irrigation costs led the bureau to pursue water power development actively following World War II. As noted above, direct federal involvement in water power had begun as a secondary aspect of navigation and irrigation projects. The Federal Power Commission had been established in 1920 to license nonfederal water power projects and to market excess power from federal dams. During the thirties the FPC was given increasing authority to investigate the potential generation, transmission, and sale of public power except within the jurisdiction of the Tennessee Valley Authority.

Attempts were made by the White House during the thirties and forties to create additional regional authorities, but these were all successfully opposed by the Congress. Thus, multipurpose projects of the Corps of Engineers and the Bureau of Reclamation generated most of the nation's publicly owned electric power.

In 1944 the marketing of power from Corps and Bureau of Reclamation dams in the Pacific Northwest was assigned to the



The Central Valley Project of the Bureau of Reclamation, begun in 1938, will ultimately supply water to irrigate about 3.3 million acres. Above, the Delta-Mendota canal is on the right and the California Aqueduct on the left beside I–5. Below, Orange groves are irrigated from a turnout structure on the Friant-Kern canal near Fresno.



Bonneville Power Administration, with the rate schedule to be approved by the FPC in order to repay generation and transmission costs to the federal government.[116]

Although controversies existed over allocation of water in the Western states, hydroelectric power generation was essentially a nonconsumptive use, returning water to the rivers after using it to drive turbines. Potential conflicts between agricultural water use and consumptive use of water, such as for the extraction and production of energy from western coal and oil shale, were to arise in the future.

Other Federal Activities

In the Eastern states, population growth in the major river basins had created a growing problem of pollution from municipal sewage discharges and urban storm runoff. Although water quality is discussed in the water quality sections of this chapter and Chapter 3, it is worth noting here that the first comprehensive legislation enacted in this regard was the Water Pollution Control Act of 1948. The act's purposes included conservation of water for recreation, fish and wildlife propagation, and public water supplies.

Relative prosperity and a shorter workweek throughout the country following World War II led many people to become interested in outdoor recreation and the aesthetic attractions of natural environments. In 1956, responding to the persistent requests of sport and commercial fishing interests, Congress passed the Fish and Wildlife Act, establishing the U.S. Fish and Wildlife Service in the Department of the Interior, to include a Bureau of Sport Fisheries and Wildlife.[117] Fish and Wildlife Service activities grew to include the improvement and maintenance of fishery resources, the planning and management of National Wildlife Refuges and waterfowl production areas, and other water-based conservation activities.

In 1962 the Secretary of the Interior established the Bureau of Outdoor Recreation within the department, and the next year Congress passed the BOR Organic Act to promote the coordination and development of outdoor recreation programs.[118] Through the Land and Water Conservation Fund Act of 1965, the BOR provides financial assistance to states and their political subdivisions for the planning and acquisition of important land and water areas for public recreation. The Bureau of Outdoor Recreation and the Fish and Wildlife Service also assess the impacts on fish, wildlife, and recreation of other federal water resource projects.

POSTWAR COORDINATION OF WATER RESOURCE DEVELOPMENTS

Interstate Compact Commissions

During the postwar period several high-level studies recommended further integration of federal water resource planning on a regional or river basin scale, with state and local cooperation. While the debate over implementation continued, Congress approved the Delaware River Basin Compact in 1961. Broad planning, regulatory, and construction authority was granted in this compact by the federal government and the four basin states—Delaware, New Jersey, New York, and Pennsylvania—to the Delaware River Basin Commission (DRBC).[119]

The terms of this compact established a precedent for the formation of the Susquehanna River Basin Commission in 1970 and the revision of other interstate compacts.[120] These compacts allow basin-wide planning and coordination of water resource development and management in part of the heavily populated and industrialized Northeast.

The Water Resources Council

By 1959, the Congress, and the Senate in particular, had seriously begun to consider legislation to improve federal-state coordination of water resource development. President Kennedy expressed an interest in such legislation and in July 1961 submitted a bill to create a federal Water Resources Council, river basin planning commissions, and a grant program to the states for comprehensive water resource planning.[121] The bill and its successors were debated for 4 years. In July 1965, 22 years after the demise of President Roosevelt's National Resources Planning Board, the Congress passed and President Johnson signed the Water Resources Planning Act, P.L. 89–80.[122]

This act contains the major features requested by the President in 1961. Section 101 established the U.S. Water Resources Council (WRC) as an independent federal agency composed of the Secretaries of Agriculture, Army, Interior, and Health, Education, and Welfare and the Chairman of the Federal Power Commission. The Secretary of Transportation was later made a member by statute. The heads of a number of other federal departments, agencies, and commissions participate in the WRC as associate members and observers. The council also has a full-time director and staff.

The 1965 act directed the WRC to publish a periodic national assessment of the nation's water resources; to establish, with Presidential approval, principles, standards, and procedures for the formulation and evaluation of federal water and related land resources projects; to help establish river basin commissions and to review their plans; and to provide financial assistance to the states for the development of comprehensive water resource plans.

In 1968 WRC published its first national assessment, *The Nation's Water Resources*,[123] which provided a comprehensive reference on national and regional water resources, present development, and projected needs. A second national assessment will be published in 1977.

Today six river basin commissions encompass the New England, Ohio, Great Lakes, Upper Mississippi, Missouri, and Pacific Northwest River Basins (see Figure 11). These commissions, established under Title II of P.L. 89–80 and authorized by the President, provide a mechanism for comprehensive water resource planning in part or all of 32 states. Three additional states are included in federal-state compact commissions. The remaining 15 states include Alaska and Hawaii and 13 Southern and Western states, where river basin planning has no commission coordination. Most of these states, however, participate in interagency committees concerned with water resources development.

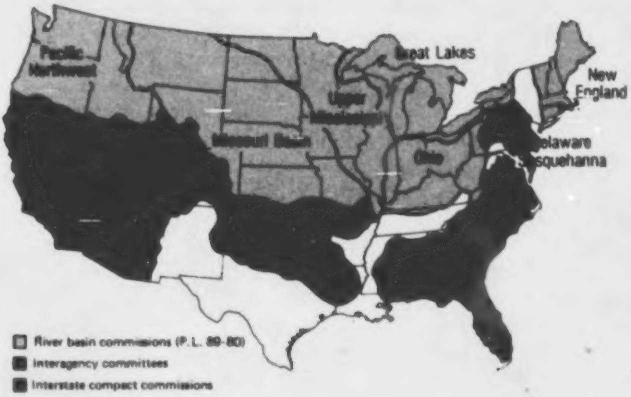
Other Federal Activities

Water resources planning was influenced by a series of other federal actions. In August 1966, concern over continued losses of life and property from floods led President Johnson to issue Executive Order 11296,[124] which directed all federal agencies to restrict the construction of federal buildings and other facilities in flood plains.

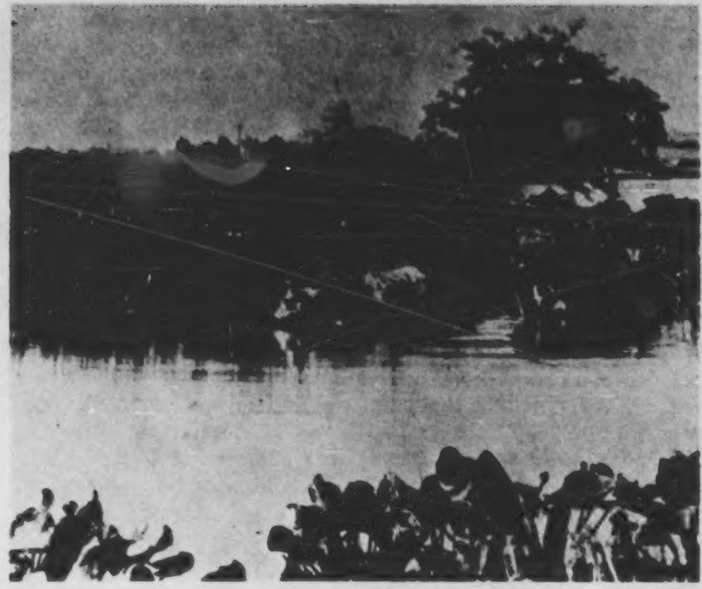
In 1968, the Congress passed the Wild and Scenic Rivers Act, which provided for the designation and protection of particularly attractive rivers or river segments in their natural state. (This legislation is discussed further in a later section on wilderness.) Also in 1968, a federally assisted flood insurance program was begun under the direction of the Federal Insurance Administration of the Department of Housing and Urban Development.[125] The new law makes federally subsidized property insurance available to residents in flood hazard areas of those communities that regulate flood plain development.

Figure 11

River Basin Planning Organizations


Pacific Northwest
Great Lakes
New England
Upper Mississippi
Missouri Basin
Ohio
Delaware
Susquehanna
River basin commissions (P.L. 89-80)
Interagency committees
Interstate compact commissions

Source: U.S. Water Resources Council.



Urban flood plain development not only increases potential flood damage but restricts other uses of the flood plain. The photo shows the Anacostia River in Washington, D.C., some time ago.

That same year, Congress established and the President appointed the National Water Commission, with instructions to "review present and anticipated national water resource problems [and] economic and social consequences of water resource development" and to prepare a report for the President and the Congress.[126] This assignment somewhat paralleled the work of the WRC, but Congress wanted the independent judgment and recommendations of a commission drawn from outside the federal government. The commission was to consume 5 years and $5 million and produce more than 60 technical papers in support of its findings, which are outlined below.

Another major influence on water resource planning was the passage of the National Environmental Policy Act of 1969. Federal agency efforts to comply with NEPA added to the importance of WRC's assignments. In December 1971, WRC published proposed "Principles and Standards for Planning Water and Related Land Resources" and invited public comment. A flood of written and oral statements was received and evaluated.[127]

The proposed Principles and Standards incorporated environmental and economic planning objectives and set forth a system of accounts for tabulating the relative merits of alternative plans. The most controversial proposal was that the "discount rate" used in the project benefit cost analyses be raised to reflect more realistic interest rates. The discount rate is used in comparing future benefits to present costs, and a higher discount rate usually lowers the benefit cost ratio of large, capital-intensive projects (such as dams) and makes smaller, less capital-intensive projects look more attractive.

The revised Principles and Standards were approved in final form by the President in September 1973.[128] They require comprehensive planning that contributes to two co-equal objectives, national economic development and environmental quality. Federal agencies are to develop alternative plans in this context and display them for comparison in each of four "accounts"—national economic development, environmental quality, social well-being, and regional economic development.

The publication in 1973 of both the National Water Commission's final report and the WRC's Principles and Standards intensified public debate over national water policy. The Water Commission report was based on 62 technical background studies, a series of public meetings, and many statements and comments.[129] The Commission identified major issues and presented a series of strongly worded conclusions and recommendations. Among other recommendations the report called for: steps to improve water conservation and reuse; a shift from continued federal construction for water resource development toward water resource planning and management, with particular emphasis on improving flood plain management; improved forecasting of water requirements, as distinguished from demands; and more rigorous economic standards for federal funding of water projects, with emphasis on increased sharing of costs by direct beneficiaries to eliminate unjustified public subsidies.

EVENTS OF THE PAST YEAR

The Water Resources Development Act of 1974

Congressional response to these recommendations and to the WRC Principles and Standards was soon forthcoming in the Water Resources Development Act of 1974.[130] While endorsing federal consideration of flood plain management alternatives to structural measures, which is discussed below, the act did not change existing cost sharing policies. The interest rate formula which resulted in a 6⅞ percent rate was specifically rejected in section 80(a) and was replaced by the earlier formula, which resulted in a rate of 5⅝ percent for fiscal year 1974 and a ¼ percent increase per year since then.[131] A further "grandfather clause," section 80(b), allowed the discount rate for most projects authorized before 1969 to be fixed at 3¼ percent for purposes of plan formulation and evaluation.

In recognition of the continuing controversy over these and other aspects of federal water policy, Congress directed in section 80(c) of the same act: "The President shall make a full and complete investigation and study of principles and standards for planning and evalu-

In April 1973 a major flood required opening the Bonnet Carre spillway (above), diverting flood waters from the Mississippi (right) into Lake Pontchartrain to reduce the danger of flooding New Orleans. The lower photo shows the river and levees in New Orleans, with Jackson Square in the foreground.

ating water and related resources projects." The study includes consideration of planning objectives, the discount rate formula, and cost sharing and is to be completed in late 1975. The President has assigned responsibility for this study to the Water Resources Council.

To provide a public forum for the expression and exchange of views on water resources policy in conjunction with the "Section 80 Study," in April 1975 the WRC convened the first National Conference on Water in Washington, D.C. Representatives from the Congress, federal agencies, state and local governments, business, and environmental groups served on eight panels. They examined water policy in relation to energy, food and fiber, transportation, municipalities and industry, environment and recreation, flood damage reduction, water laws and water rights, and the role of governments.[132] The recommendations of each panel were considered by the section 80 study team and the Water Resources Council members.

Flood Damage Reduction

During the past year considerable attention was given to certain requirements of the National Flood Insurance Program (NFIP) of the Federal Insurance Administration (FIA). The Flood Disaster Protection Act of 1973 increased previous limits of flood insurance coverage while making future federal financial assistance (including most bank loans) in identified flood hazard areas contingent upon participation of the community in the NFIP.[133] Although many communities have qualified for the program, some have objected to the act's required community flood plain development standards. Several bills have been introduced in the Congress this year to alter this requirement and/or extend the July 1, 1975, deadline for continued federal assistance to communities where flood hazard areas have been identified and mapped by or for FIA.[134] In the absence of more comprehensive land use legislation, the NFIP provides a stimulus for land use planning at the local government level. However, the General Accounting Office recently reviewed progress of the program and concluded that a shortage of manpower and funds has restricted the essential mapping of flood hazard areas by federal agencies.[135]

Another important stimulus for management approaches to flood damage reduction was provided by the Congress in section 73 of the Water Resources Development Act of 1974, which states in part (a):

> In the survey, planning, or design by any Federal agency of any project involving flood protection, consideration shall be given to nonstructural alternatives to prevent or reduce flood damages including, but not limited to, floodproofing of structures; flood plain regulation; acquisition of flood plain lands for recreational, fish and wildlife, and other public purposes; and relocation with a view toward formulating the most economically, socially, and environmentally acceptable means of reducing or preventing flood damages.[136]

Part (b) of this section establishes a policy for local cost sharing, where such an alternative is recommended, similar to that for structural protection measures. Other sections of the act provide planning authorization for three initial projects in which the Corps of Engineers indicated that nonstructural measures would be considered—the Charles River Watershed, Massachusetts; Prairie du Chien, Wisconsin; and a project below Chatfield Dam near Littleton, Colorado.[137]

The Corps of Engineers as well as other federal agencies and national environmental organizations actively support full consideration of nonstructural alternatives, which could provide flood-prone communities with long-term benefits of flood damage reduction, open space for public recreation, and protection and enhancement of natural ecosystems, often at lower costs to the federal government than equivalent structural measures. However, certain inconsistencies in cost sharing policy are being resolved by the Administration before the agencies commit federal funds to these and other nonstructural flood protection projects.

The environmental impacts of several more traditional federal flood control projects were the subject of extensive study and public debate during the past year. The Tocks Island Lake Project was authorized by the Congress in 1962 as a proposed multipurpose dam and reservoir on the upper Delaware River between Pennsylvania and New Jersey. Land acquisition began in 1968, and a final environmental impact statement was filed with CEQ in October 1971. During this period growing concern was expressed by private groups and public officials about the proposed project, centering on the water quality of the proposed impoundment and the impacts of the project on the surrounding area. Various alternatives to the project were suggested.[138] In the summer of 1972 Congress directed the Corps, in cooperation with the Delaware River Basin Commission, to employ independent consultants to undertake a comprehensive and impartial study of the project and alternatives. The five-volume study, released in July 1975, is the most comprehensive analysis ever published of a proposed federal water resources project.[139]

After reviewing the results of this study, on July 31, 1975, the Governors of the four DRBC states voted 3 to 1 to ask the Congress not to appropriate funds for construction of the dam. They recommended instead that Congress fund the completion of land acquisition for a national recreation area of 72,000 acres along the free-flowing river in Pennsylvania and New Jersey.

The Red River Gorge is a scenic natural area in the Daniel Boone National Forest near Lexington, Kentucky. The numerous natural and cultural features of the gorge are of high scientific, educational, aesthetic, and recreational value—1 million visitors are attracted to the area each year. In order to provide flood protection downstream as well as recreation and water supply benefits, the Corps of Engineers proposed a dam and reservoir on the Red River that would flood portions of the gorge. A final environmental impact statement for the project was filed in July 1974.

Much of the Delaware River valley shown in this photograph, taken above Stroudsburg, Pa., would have been inundated by the Tocks Island Lake. The states and the federal government are now considering other possibilities for recreation and flood control in the region.

On August 19, 1974, private parties filed suit to enjoin the project;[140] the Corps then agreed to delay the project in order to respond to the criticisms raised by the plaintiffs and others. In May 1975, U.S. District Court Judge Rhodes Bratcher granted plaintiffs a temporary restraining order, and the project is presently before the court for further hearings. On September 11, 1975, Kentucky Governor Julian Carroll announced his opposition to construction of the dam.

In July 1974 the Department of Agriculture released a study of the Small Watershed Program,[141] which is administered by the Soil Conservation Service. The study showed that although flood protection for agricultural land continues to be the primary purpose of the program, it has been gradually expanded into a multipurpose program that includes development of recreation, fish and wildlife resources, and water supply. Project investment in water-based recreation facilities has undergone the most expansion, increasing more than eight times over average levels in the mid-1960's, with highest demand in the Atlantic and Pacific coastal regions.

The channelization of streams for flood control and improved drainage continues to draw criticism, primarily for its adverse environmental effects. However, the SCS has recently improved project planning and environmental assessment procedures to consider more systematically the environmental effects of and alternatives to stream channelization.[142] Some proposed channel work has been dropped from project plans or scaled down to clearing debris from existing streambeds and floodways.

Irrigation

Legal and political disputes have arisen over whether Bureau of Reclamation programs are in accordance with the acreage limitations and residency requirements of the 1902 Reclamation Act[143] and if not, whether the act should be amended.

The National Water Commission recommended that federal subsidies to new irrigation projects be ended and direct beneficiaries be required to pay full irrigation costs of new federal projects.[144] The recommendation has been greeted with dismay by farmers of irrigated lands, who maintain that their production of food and fiber is in the national interest and therefore deserves continued subsidy. This issue is being considered in the section 80 study as part of the overall review of cost sharing.

Construction proceeded during 1975 on the Garrison Diversion Unit despite numerous environmental and economic objections raised by federal agencies, farmers' organizations, and environmental groups. The project would irrigate 250,000 acres of ranch and farmlands in North Dakota with water diverted from the Missouri River. According to the final environmental impact statement, irrigation return flows high in dissolved salts would enter the Souris and Red Rivers, which flow into Canada. The Canadian government is disturbed over the possibility that these flows would harm the health and property of its citizens in violation of the Boundary Waters Treaty of 1909. The State Department has informed Canada that the project will not be carried out in a way that would violate the treaty. Both sides have taken steps to refer the matter to the U.S.-Canadian International Joint Commission for review and recommendations.

U.S. critics of the project have cited escalating project costs, dislocation of family farms, inadequate wildlife mitigation measures, and repeated slumping along the banks of the McClusky Canal as reasons why the project should be stopped.

The Oahe Unit in South Dakota is similar to the Garrison Diversion in several ways. Both are intended to divert water from the Missouri River eastward for irrigation and thence to the James River. Potential environmental impacts include poor water quality, fish and wildlife destruction, and land unsuitability. Of particular concern are effects on the James River because it may also receive irrigation return flows from the Garrison project to the north.

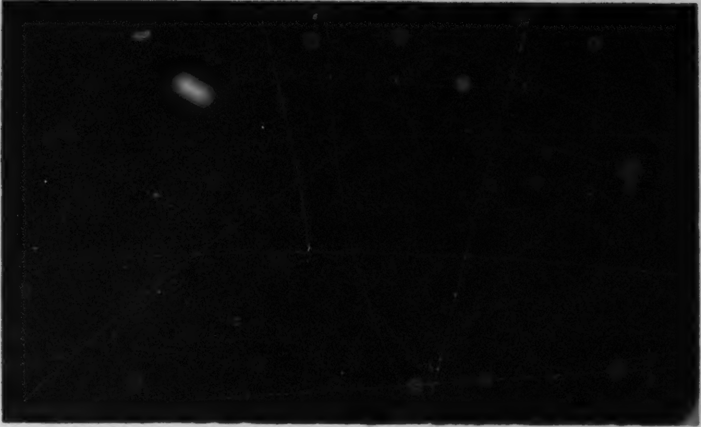
Navigation

The Corps of Engineers maintains 25,000 miles of waterways, 107 commercial port facilities, and 400 small boat harbors. Annual costs of this work approach $200 million and annual dredging volumes exceed 350 million cubic yards.[145] The environmental effects of this program—particularly the disposal of dredged material in open water and in marshes and wetlands—have earned it much criticism by environmental groups. In an effort to learn more about the effects of dredging and disposal operations and to find beneficial uses of dredged material, such as the creation of marshes and islands for wildlife habitat, the Corps established the Dredged Material Research Program at the Waterways Experiment Station in Vicksburg, Mississippi, in 1973.

The most controversial navigation project in recent history has been the Cross-Florida Barge Canal. First authorized for survey by the Congress in 1826, the project was kept alive in the planning stage for more than a century. Construction finally began in 1935, then stopped after the war. Work began again in 1967. Conservation opposition to the project snowballed, and construction was halted again in 1971 by President Nixon in order to prevent potentially serious environmental damages to the Oklawaha River, the Ocala National Forest, and ground water in the Floridan Aquifer.

In January 1974, barge canal proponents obtained a District Court order releasing impounded project funds to the Corps for the preparation of a complete environmental impact study of the project, including information relevant to management of the completed portions.[146] By July 1975 the Corps had completed the data gathering phase of a two-part study, prepared a status report, and entered the data analysis phase. The study is being monitored by an Interagency Coordinating Group of state and federal officials.

Another proposed navigation project that received the attention of the courts this past year is the planned replacement of Locks and Dam 26 on the Mississippi River near Alton, Illinois. The Corps of Engineers plans to replace the existing structure with a larger one that could open the upper Mississippi to deeper-draft barges, probably tripling such traffic and requiring additional lock replacements and more dredging to maintain a deeper channel. Ruling on suits brought by a number of railroads and two environmental groups, D.C. District Judge Charles Richey issued an injunction against the Corps because its environmental impact statement considered neither the cumulative effect of expanding this navigation system nor alternative methods of transporting goods. The court also ruled that the Corps lacked specific Congressional authorization for the project.[147] The Corps has prepared an extensive draft supplement to the pre-



The Corps of Engineers operates Locks and Dam 26 on the Mississippi River above St. Louis as a service to waterway users. A series of such locks and dams provides a 9-foot navigation channel upriver to Minneapolis.

vious EIS and is currently seeking a specific authorization for the project from the Congress.

Regulatory Functions—The "404" Controversy

In the fall of 1974 the Natural Resources Defense Council brought suit against the Army over the Corps's interpretation of its jurisdiction under section 404 of the 1972 Federal Water Pollution Control Act. The plaintiffs contended that the Corps had improperly limited its jurisdiction over the disposal of dredged or fill material to older definitions of "navigable waters" rather than to "waters of the United States" as called for in the 1972 act and further, that the expanded jurisdiction was intended to provide needed protection for dwindling coastal marshes and inland wetlands. The court ruled in favor of the plaintiffs and directed the Corps, in cooperation with EPA, to prepare proposed regulations expanding its jurisdiction accordingly.[148]

The proposed regulations were published by the Corps in May 1975 in the form of four alternatives, one of which asserted jurisdiction over the disposal of material "in virtually every natural and artificial water in the United States." [149] Considerable controversy ensued over whether the construction and maintenance of farm ponds and irrigation ditches and even the plowing of fields would be subject to Corps permit authority. Over a dozen bills were introduced seeking to clarify or restrict this section of the law.

After reviewing over 4,000 comments, the Corps and EPA agreed to seek administrative rather than legislative clarification if possible, and on July 25 the Corps published revised interim regulations,[150] subject to modification as a result of comments received during an additional 90-day review period. These regulations extend Corps jurisdiction to wetlands and other waters in three phases, but they exempt normal farming and certain other activities from coverage.

ISSUES TO WATCH FOR

A number of important water resources policy issues emerge from our discussion of recent events. New approaches to flood control, water-based recreation, and wetlands protection reflect increasing attention within the federal government to environmental quality. But there is also a continuing heavy emphasis on construction. The full range of water resource management options, which include nonstructural alternatives, must be considered for productive long-term use of the nation's aquatic resources. Consideration of these options is biased as long as federal funds are made available for some project alternatives but not others.

Response to the Section 80 Study

The executive branch and the Congress will each receive and consider the results of the Water Resources Council's review of planning objectives, cost sharing, and the discount rate. Legislation and/or executive orders may be proposed affecting the present language of the WRC Principles and Standards in regard to these issues.

Flood Damage Reduction

Resolution of the present cost sharing questions affecting the implementation of Section 73 of the 1974 Water Resources Development Act is expected; meanwhile the planning and consideration of nonstructural flood control measures are underway. As additional communities are mapped and included in the National Flood Insurance Program, local flood plain management will become more effective in reducing damages. However, the application of sanctions to nonparticipating communities will increase the pressure on Congress to extend deadlines or otherwise to weaken the compulsory aspects of the program. Some communities may seek federal funds for structural solutions to flooding in order to reduce the size of flood hazard areas subject to sanctions or controls on development.

User Charges on Inland Waterways

User charges have been consistently opposed by the water transportation industry on the basis of federal laws and tradition. But federal funding of waterways development and maintenance from general revenues is a continuing public subsidy of this form of transportation. It is the Administration's position that legislation instituting some means of recovering federal costs is needed—tolls based on ton-miles, lockage fees for pleasure boats, fuel taxes, or some combination of means. Although the railroads obviously favor such measures, resistance is high from waterways users, so these proposals may go forward slowly.

Water for Energy

Until recently, nearly all water use for energy production has been nonconsumptive—water passing through turbines in hydroelectric powerplants and back to a river channel again. Withdrawals of surface or groundwater for steam-electric power or evaporative cooling have been a small fraction of the available supply. The prospects of coal conversion, including electric power generation, gasification, and liquefaction, and the processing of oil shale on a large scale in water-short areas of the Western United States raise a significant issue of competition with existing agricultural and municipal uses. Large amounts of water are consumed in the carbon-to-hydrocarbon conversion of coal to synthetic gas. Energy interests can probably afford to purchase sufficient water, but other users may seek market controls in order to retain water for their needs.

A report recently released by the Department of the Interior indicates that water supplies in the upper Missouri River basin should be sufficient to meet all projected energy development needs through the year 2000.[151] Studies of the upper Colorado basin, where extensive oil shale development is planned, indicate the possibility of significant shortages there by the year 2000.[152] These estimates may change as new technologies for energy conversion are developed and as more information about water needs for long-distance coal slurry pipelines becomes available. In section 13 of the 1974 Federal Nonnuclear Energy Research and Development Act, the Administrator of ERDA is authorized to request the Water Resources Council to assess water resource requirements and water supply availability for any nonnuclear energy technologies which are the subject of federal research and development efforts.[153]

Water resources issues involving coastal zone management, fish and wildlife, and water pollution control are discussed in other sections of this report.

PUBLIC LANDS

To a citified easterner accustomed to thinking of land as either public park or someone's private property, the idea of public lands may seem out of the ordinary. Not so to most westerners. To ranchers whose cattle graze on public range, or campers who sleep in National Forests, or prospectors who stake claims for copper or uranium on the public domain, the fact that one-third of the land in the United States belongs to all its citizens comes as no surprise.

In the lower 48 states, 17 percent of the land is publicly owned. Alaska is a separate case—until statehood, the federal government owned 95 percent of the land. Even after land transfers to the state and to Alaskan natives are completed, one-half of Alaska will still be federally owned.

At one time or another most of the land in the United States belonged to the public. The original 13 colonies ceded their unsettled lands west of the Appalachians to the United States when the Union was formed. The Louisiana Purchase and the Mexican acquisitions added millions more acres to the public domain.

For a long time the public, through government, made every effort to get rid of its land. At least until the turn of the 20th century, it was the policy and intent of the U.S. government to convey public lands to private hands so that the land might be put to better use through the interest and industry of its owners.

The Homestead Acts sold land for nearly nothing to anyone who would farm or ranch it. Vast tracts of land were given to the railroads after the Civil War in the interest of opening up the continent and uniting East with West. The Mining Law of 1872, one of the basic laws still on the books, not only gave minerals under the land to anyone who could find them but virtually gave the land too if the claimant wanted it. Under the Timber and Stone Act of 1878, some of the heaviest and finest forests on earth were sold for $2.50 per acre.

A change in attitude was slow in coming. The concept that public ownership of land gave an opportunity for stewardship, for pursuit of some goods that benefit everyone in common but enrich no one in particular, began to develop toward the end of the 19th century.

As long ago as 1872, the Yellowstone Act reserved 2 million acres of the public domain to form the first National Park—"a pleasuring ground for the benefit and enjoyment of the people" and a place to preserve "natural curiosities, or wonders" in their natural condition.[1]

Forest reserves, the forerunner of our National Forests, were established in 1891. The main purposes of the reserves were envisioned as ones that public ownership rather than private enterprise could best serve. They were protection of watersheds, prevention of floods, and forest management to assure a sustained yield of timber.

Additions to the reserves came slowly through the next 10 years. At the same time, the conservation ethic was growing. Reckless exploitation of the immense natural resources of the United States, especially rapacious timbering with its aftereffects of erosion and floods, had aroused real fears for the physical welfare of the country.

Outdoors-loving, conservation-minded Theodore Roosevelt changed the handling of public lands while he was President. He appointed the great conservationist Gifford Pinchot chief of forest reserves, and together they built up the reserves from 40 million to 190 million acres, but not without protests. In the West, where ranchers, miners, and adventurers of all kinds were accustomed to think of public lands as theirs for the taking, there was outrage when Roosevelt and Pinchot staked out prairie and even semidesert as well as timberland for forest reserves. Roosevelt stood his ground, and looking back as ex-President, chose conservation as his most important achievement.

The conservationist legacy of National Forests is largely intact today. There have been additions as well. Since Roosevelt's time, not much more land has been set aside for National Forests from the western public domain, but in the East 23 million acres has been acquired for a great National Forest System.

Of the 738 million acres of public lands today, approximately 450 million is administered by the Bureau of Land Management in the Department of the Interior. It is known as national resource lands. The National Park Service administers 31 million acres and 32 million is in Wildlife Refuges. The National Forests, which have contributed millions of acres to National Parks, now amount to 187 million acres. The remaining public lands are held by various other government agencies.

The newest classes of public lands are Wilderness and the combination of land and water comprising the Wild and Scenic Rivers System. As the National Forests were created by withdrawal from the public domain, so Wilderness Areas have been set aside, mostly within National Forests. They are meant to be inviolate; no roads shall disturb them, or other works of man. Some may be used for grazing. Most are open to mining for another few years, but eventually they will revert to or remain in an entirely natural condition, "unimpaired for future generations."[2] So far, 12.7 million acres has been set aside for Wilderness and another 27 million proposed by the Administration.

Today there is nearly universal agreement that public lands can and ought to serve public purposes which private ownership of land cannot fulfill. The old intent to dispose of public lands wholesale has been abandoned. There is also a consensus on the broad purposes for which public land should be used, preservation and conservation through wise use of resources. The Congress defined some of these purposes in the Multiple Use-Sustained Yield Act of 1960, spelling out five chief uses for the National Forests—outdoor recreation, fish and wildlife, timber, watershed, and range. Mining is not excluded in the National Forests and wilderness is another important use. The purposes of the national resource lands of the public domain have never been explicitly defined in law; at present mining and grazing are the chief uses. Agreement has grown that these lands, like those of the National Forests, should be put to multiple use.

Consensus on the broad purpose does not end controversy about the use of public lands. No manager of any class of public lands can escape the task of balancing one good use against another and therefore of making difficult choices among conflicting uses.

Preservation is the prime purpose of the Wilderness Areas, the Wild and Scenic Rivers System, the National Parks, and to a large extent, the Wildlife Refuges. For wilderness the conflicts arise at the outset. Just how much area is to be set aside to be maintained in a natural state with no development by man? Private timbering, mining, and grazing interests generally want to limit the amount of land set aside as wilderness. Environmental groups generally want to enlarge it. It is sometimes thought that the private and the public interests are at opposite poles, but indeed they cannot be so neatly separated.

There is in fact a public interest in using resources on the public lands within the limits that prudent conservation imposes. The wood, copper, uranium, oil and gas, coal, phosphate, and dozens of other valuable resources on or under the public lands are obviously useful to the public as well as profitable to the private entrepreneur who develops them. Then again there may be private interests—a dude ranch on adjoining land, for example—which would like to see part of a National Forest preserved as wilderness for its scenic value rather than open for mining, timbering, or developed recreation use.

Ranchers have a private interest in enlarging their grazing rights on public lands, and the public has an interest in the beef that graze there. The public also has an interest in preserving natural ecosystems, exemplified by the antelope and other wildlife that may be crowded off the range by grazing cattle.

One more conflict may be briefly mentioned. Recreation and preservation may easily be at odds in National Parks and Forests. Motorcycles and other offroad vehicles can trample delicate plants, compact earth, and obliterate relics of prehistoric times. Too many cars, too many camper vehicles, even too many people on the trails can destroy the very "natural wonders" that people came to enjoy.

Having said all this about conflicting interests, public and private, let us return to a principle of public lands management. Their primary purpose is use for the common good, often in ways that are not profitable for private enterprise. The purpose of grazing on public lands is not necessarily to produce the most beef—it is to use rangeland for balanced, multiple purposes, preserving natural ecosystems and enriching the land through conservative care.

For timberland the aims for public lands must also be broad. Flood control, preservation of wildlife, and scenic beauty receive equal consideration with good forest management for sustained production of wood. For this last aim public lands may be managed differently than even the most enlightened and farsighted of private timber interests would do; there is no one right way to manage a forest. Public ownership of forests allows more conservative, less immediately profitable management methods in accord with the highest standards of environmental protection.

In short, the public lands are a national treasure. They allow us to preserve some corners of the earth in a state that is scarcely disturbed by man and to manage others with the broadest and most long-range vision of the common good.

GRAZING

BACKGROUND

Grazing is a very old use of the public land and is an important one economically. Thirty-one percent of the nation's rangeland—about 373 million acres—is on public lands. The Bureau of Land Management manages 163 million acres as range, and the Forest Service permits grazing on 105 million acres of the 166 million that it administers outside Alaska. Nearly all the rest is in National Parks and Wildlife Refuges. Altogether, 266 of the 373 million acres[3] of publicly owned range is being grazed.

Some 5 million head of cattle (8 percent of the U.S. total) and 7 million sheep (42 percent of the total) graze at least part time on public lands.[4] The public range is especially important in the Western states. It provides 17 percent of all feed for sheep and beef cattle in the 11 Rocky Mountain and Far West states.[5]

Grazing on BLM Lands

The Taylor Grazing Act, enacted in 1934, provided for managing the public range for conservation and long-term productivity.[6] It was presented as an interim measure for managing public range "pending its final disposal." The act gave the Department of the Interior authority to manage grazing land and set up grazing districts with the number of livestock to be limited and grazing privileges allocated through federal licenses. These measures would stabilize the livestock industry, increase grazing capacity, and protect the range. At the time of enactment, it was estimated that over 90 percent of the public domain land was deteriorating.

Many scientific principles of range management were understood at that time, but many advances have been made since. Overgrazing can reduce the productivity of the range, but a well-managed range can support many more animals. Proper management provides for controlling the number of animals in relation to how much forage there is. It means keeping them well-distributed over the land, which is accomplished by herding, placement of water tanks and salt, and fencing. Sometimes a range is managed by removing overgrown brush and replanting it in grass. Good management requires timing of use and may include a system of rest and rotation for the land.

The Taylor Grazing Service (1934) and the General Land Office (1812) were combined in 1946 to form the present Bureau of Land Management.[7] BLM is an administrative invention, with only piecemeal legal authority. In more than 3 decades of assigning grazing privileges, it has been handicapped by the lack of an organic act which would clearly establish its powers and define the purposes for managing its lands. Operating under this handicap, BLM has found it difficult to carry out the conservation aims of the Taylor Grazing Act.

In a 1975 report,[8] BLM rated one-half the grazing land under its stewardship in fair condition. Another 28 percent is rated poor, and 5 percent is bad. Fifteen percent is rated good and only 2 percent excellent. BLM defines these condition classes as follows:

- Range in excellent condition is producing all or nearly all of the forage that it can and has a fully productive stable soil.
- Range in good condition is generally satisfactory although it produces less forage than a similar site in excellent condition. Erosion, if any, is slight.
- Range in fair condition is unsatisfactory, with both soil and plant cover deteriorated. Valuable forage plants are substantially reduced and they are replaced by less-palatable perennial grasses, weeds, and shrubs or by bare ground. There is less likely to be active erosion.
- Range in poor condition has lost so much vegetative cover and topsoil that it produces only a fraction of the forage grown on similar sites in fair, good, or excellent condition. Few of the more valuable perennial plants remain.
- Range in bad condition has lost most topsoil. It has only a sparse stand of low-value plants. The remaining soil is exposed to erosion by wind and water and active erosion occurs.

Eighty-three percent of the grazing lands in the public domain managed by BLM is in fair, poor, or bad condition. The 50 million acres in poor or bad condition equals in land area the state of Utah.

In poor condition, this BLM range land produces only a fraction of its forage potential.

Range condition and soil erosion are closely related because poor vegetative cover creates conditions for erosion. An inventory of erosion conditions conducted on 144.5 million acres of the national resource lands indicates that 91 percent is presently sustaining some soil loss. Ten percent of these lands is subject to critical or severe erosion, and another 35 percent is considered moderately eroding, that is, it sustains soil loss during heavy storms and has sustained some loss of productivity.

Grazing in the National Forests

The National Forest System contains 166 million acres of actual or potential grazing land, much of which is wooded forest range. The Forest Service has clear legislative authority to correct abuses and to manage grazing as part of a balanced system of multiple use.[9]

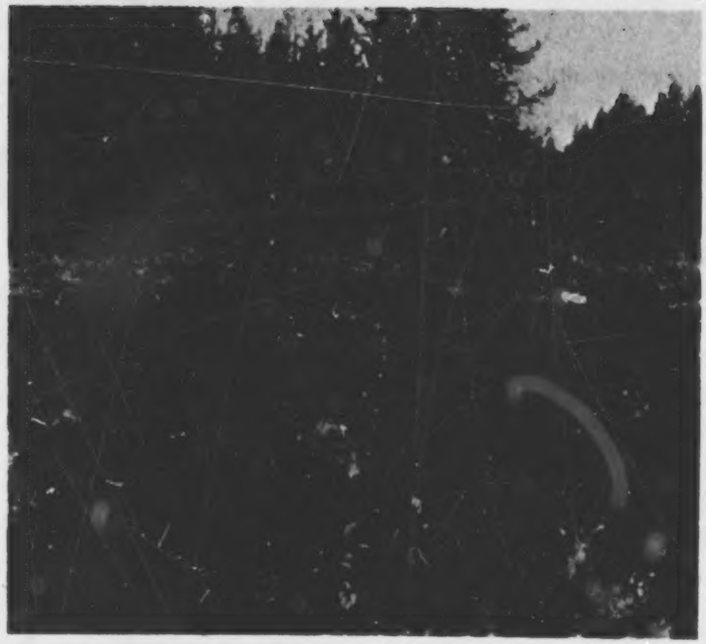
Much of the range in the National Forests could produce more forage. The Forest Service has evaluated its own practices on 49.3 million acres of rangeland and concluded that 10.4 million acres, or about one-fifth, is producing somewhere near the forage that it can. Forty-three percent of the rangeland, or 21.3 million acres, is producing from 40 to 60 percent of its potential, and the rest is below 40 percent of its potential.[10]

In a 1972 forest range environmental study, the Forest Service concluded that it is quite possible to manage grazing at competitive costs and still enhance environmental quality. In the traditional grazing areas of the West, however, it would be difficult to maintain grazing and at the same time improve the environment at reasonable cost on low-productivity lands in poor condition.[11]

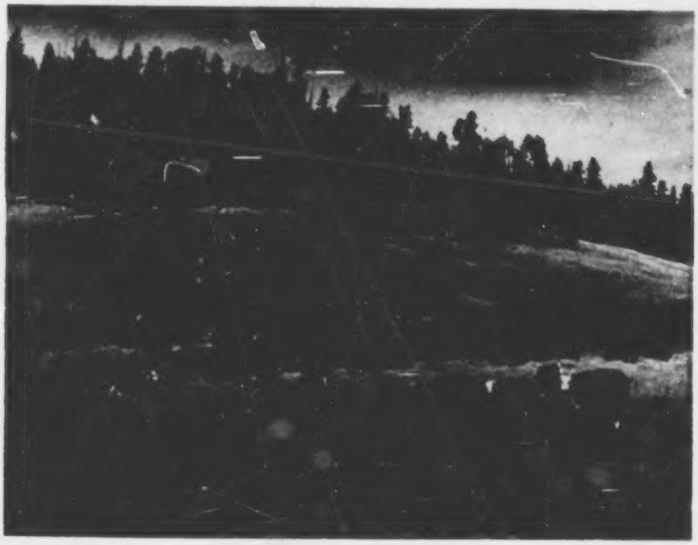
The Department of Agriculture in its "red meat" study in 1974 suggested that grazing could be more than doubled on U.S. ranges.[12] Forage, which only ruminant animals can eat, can replace heavy use of corn or other feed grains to produce red meat (beef, lamb, and mutton).

The USDA study did not address the problem of upgrading the grazing lands that are now in a deteriorated condition. One of the essentials for restoring land to higher productivity is to control the number of animals foraging on it. Along with controlling numbers, improved grazing systems and range improvements to control livestock are important methods. The USDA findings on grazing potential rest heavily on the expanded use of eastern forest range, but the 1972 Forest Service study found that nearly half the 160 million acres of eastern forest range (both public and private) was being overgrazed. Forest cover and soil were suffering from overgrazing and poor management.[13]

Another problem that the USDA study did not fully address is how single use of grazing lands for red meat production impacts watershed protection, recreation opportunities, and wildlife habitat.



Overgrazing destroyed ground cover on St. Joe National Forest, Idaho, with resulting erosion of the land, above; below, cattle graze on Wyoming national forest land that is in satisfactory condition.



Range Conditions

In response to a request by the Senate, the Bureau of Land Management prepared the *Range Condition Report.*[14] The conditions observed on these rangelands are disquieting. Two-thirds of the land is in fairly stable condition; of the rest, a little over one-half is improving, but almost an equal amount is deteriorating. (Table 19 summarizes the results of the report.)[15]

BLM took a special look at conditions in Nevada[16] in response to reports that range conditions there were in an alarming state of deterioration. Nevada has a higher proportion of public domain lands managed by BLM than any other state—68 percent.

The Nevada survey helps to point out the magnitude of our rangeland problems and some of their causes. Among the chief problems that the report identified are: too many livestock; allowing increases in livestock without prior study; allocation of forage for livestock without considering the needs of wildlife, wild horses, and wild burros; failure to carry out intensive livestock grazing management programs where they do exist (both BLM and holders of permits are at fault for neglecting the programs and the allotment management plans on which they are based); failure to follow up improvement projects, such as revegetation, with proper grazing management; and neglect of historical and archeological values.

According to BLM Director Curt Berklund, similar studies of other states indicate that the Nevada findings are not unique. Berklund directed BLM to take corrective action in managing its grazing lands to include more supervision of range use—for example, enforcement of compliance with grazing plans and control of livestock trespass; adjustment of the number grazing to range capacity; a realistic apportionment of the forage requirements of wildlife, wild

Table 19

National Resource Lands Range Conditions

	Present condition				
	Excellent	Good	Fair	Poor	Bad
Percent	2	15	50	28	5
Acreage, in millions	3.2	24.4	81.5	45.6	8.2
	Range condition trends				
	Improving	Static	Declining		
Percent	19	65	16		
Acreage, in millions	31.0	105.9	25.7		

horses, and burros; and consideration of environmental impacts of competing land uses.[17]

Overgrazing and the concomitant deteriorating range conditions have not escaped public notice. On October 30, 1973, the Natural Resources Defense Council filed a complaint against BLM in the District Court for the District of Columbia, requesting declaratory judgment to prohibit the issuance of any grazing licenses on BLM lands until the requirements of the National Environmental Policy Act are fully met.[18] The suit asked for a full assessment of grazing impacts and consideration of alternatives to grazing, but it did not ask to have all animals removed from the public lands pending compliance, noting that NEPA could not be implemented overnight.

On December 30, 1974, the court found in favor of NRDC. BLM then agreed to prepare an environmental impact statement for each of 212 geographical areas—a total of 150 million acres of rangeland. Each statement will cover a group of BLM's grazing plans and discuss in detail the impact of all existing or proposed livestock grazing and of such grazing practices as fencing, livestock water development, spraying, brush removal, and seeding with grass.[19] A schedule for this program was set through 1988. It begins this year with development of a model environmental impact statement for the Challis Planning Unit, Salmon District, Idaho. BLM also agreed not to implement any new grazing plan after fiscal year 1975 without having completed impact statements.

Grazing Fees

Fees for grazing livestock on public rangelands have been a subject of controversy for years. The Forest Service began imposing fees for grazing on the National Forests as early as 1906. On the unreserved lands of the public domain, no fees were required until 1934. With passage of the Taylor Grazing Act, fees were based on the cost of administering grazing permits. This concept, which resulted in extremely low fees, was developed to mollify opposition to the act among ranchers and western Members of Congress.

The legacy of this compromise was to make it difficult for many years to raise fees and use the funds for good range management. The first fee set by the Taylor Grazing Service (predecessor to BLM in managing grazing on unreserved lands) was 5 cents for a month's grazing for one animal (an animal unit month, or AUM).

Years went by before the concept of paying fair value for use of federal rangelands began to replace the traditional attitude that public lands are free. In 1968, after a joint BLM-Forest Service survey of western livestock grazing, the two agencies established a common system for establishing fair market value for grazing and a method for calculating fees.[20]

At the time of the study, the BLM fee was 33 cents and the National Forest fee was 60 cents per AUM. A schedule set in 1969 allowed 10 years for the fee to rise to full market value.[31] This approach provides a fair return to the public for its range resource. In addition, many conservationists believe that charging fair market value encourages better land stewardship and range practices.

The schedule for raising grazing fees on the public lands to fair market value has been postponed temporarily. Earlier it was extended to 1980 because of a moratorium on fee increases in 1970 and again in 1972.

On January 16, 1975, the Secretaries of Agriculture and Interior announced a new moratorium on the scheduled increase in grazing fees "in recognition of the difficult economic and drought conditions facing the livestock industry throughout the Western States."[32] This moratorium is not intended to delay reaching a fair market value by 1980. The moratorium means that grazing fees will remain at $1 per animal unit month on national resource lands and $1.11 per AUM on National Forest lands until the schedule is resumed. Without the moratorium, the grazing fee would have been raised to $1.51 on resource lands and $1.60 on National Forest System lands.

There are proposals now before the Congress to fix grazing fees by law.[33]

Wild Horses and Burros

Wildlife—deer, antelope, elk, and the like—are not the only creatures that compete with cattle and sheep for rangelands. These lands are also home for two species that man introduced into the western grazing lands, wild horses and burros. A few years ago, reports of their wholesale commercial slaughter sparked a public reaction that led to the Wild Free Roaming Horse and Burro Act of 1971, which charged the Interior and Agriculture Departments with protection and management of these animals on public lands managed by BLM and the Forest Service.[34]

Wild horses and burros are far from vanishing. They live on 50–60 million acres of national resource lands and National Forest lands in 10 Western states. Improved surveys show that earlier estimates of their number were low. The Forest Service and BLM estimate that there are 27,000 wild horses and 14,000 wild burros, unbranded and unclaimed, grazing on public lands. Also roaming the public lands are 17,000 horses and 100 burros that have been claimed for private ownership.[35] Some herds have an annual growth rate of 20 to 25 percent.

According to the language of the law, "Wild free roaming horses and burros are living symbols of the historic and pioneer spirit of the west," and they "enrich the lives of the American people." But like domestic livestock and many kinds of wildlife as well, too many wild horses and burros may overstrain the resources of the range. Eventually the land may not be able to support their number and the animals will die.

Although the act authorizes control of wild horse and burro populations, it denies use of methods that Agriculture and Interior believe necessary. The Department of the Interior and the Congress have suggested amendments that would permit use of aircraft and other motorized vehicles to round up the animals and get them off the range; another amendment would authorize the two Secretaries to sell or donate excess animals to private individuals or organizations.[26]

On February 28, 1975, a three-judge federal panel in Albuquerque, New Mexico, declared the Wild Free-Roaming Horse and Burro Act unconstitutional.[27] The suit was brought by the New Mexico Livestock Board when a rancher asked the Bureau of Land Management to remove wild burros from land for which he had a grazing permit. BLM refused, and he then contacted the board, which rounded up the burros and auctioned them off. BLM demanded that the burros be returned to the public domain.

The court found that the horses and burros are not the property of the United States but of the states and the Congress has no control over them—the United States may not regulate the wild horses and burros except for protection of its land. The law was aimed at protecting the animals, not the land on which they live.

The federal court in New Mexico granted a temporary stay of its order so that BLM may continue to regulate wild horses and burros while the case is appealed to the Supreme Court.

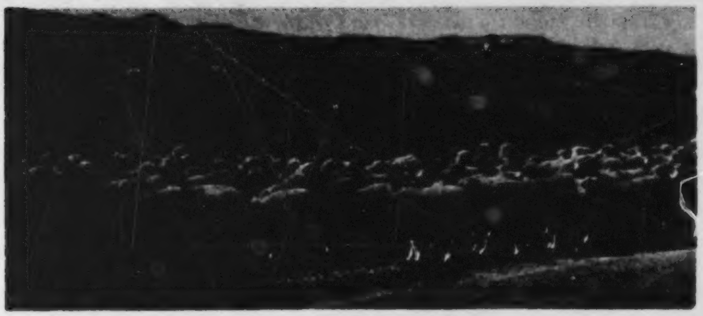
ISSUES TO WATCH FOR

Wildlife

Preservation of wildlife is one of the main purposes of National Forests, and the Forest Service is cognizant of managing its range consistent with this and other chief uses. BLM has no direction from the Congress analogous to the 1960 Multiple Use-Sustained Yield Act for the Forest Service.[28]

Deer, antelope, elk, and many other forms of wildlife are often in competition with domestic livestock for forage on public lands. The interrelationships are complex and more remains to be learned about them. BLM's Senate and Nevada reports both indicate that wildlife does not fare well under present management techniques. Thirty-three species of wildlife on the official United States List of Endangered Fauna[29] are found on BLM range, and BLM reports that "[p]ublic land management at the existing level may not insure the survival of these endangered species."[30] Similarly, the Nevada report states that "[u]ncontrolled, unregulated or unplanned livestock use is occurring in approximately 85% of the state, and damage to wildlife habitat can be expressed only as extreme destruction."[31]

Stream habitat too is affected by overgrazing. The Nevada study reported 883 miles of streams with deteriorating and declining habitat.



Careful management, including seasonal use of forage, has kept this Colorado sheep range on BLM land in good condition.

It went on to comment that "grazing systems do not protect and enhance the wildlife values." [32]

The specific impact of past and present grazing practices on wildlife is not entirely clear and data are scarce. Starker Leopold of the University of California Department of Forestry and Conservation has called attention to the possibility that livestock grazing may be having cumulative ill effects on the productivity of western lands and waters. Reporting on widespread deterioration of the quality of deer forage in the spring and summer range and along the migrating routes, he surmises that persistent livestock grazing is a major contributor to this effect. Overgrazing may affect other wildlife besides the herbivores. Persistent overgrazing by domestic livestock appears to be the primary cause of depletion of the quail food supply in California.[33]

Multiple Use of Rangelands

The need to protect wildlife as well as watershed and other values on rangelands under BLM management points up the necessity for explicit legislative authority for BLM to manage its lands for multiple purposes. The Natural Resources Defense Council suit against BLM focused on the need for better planning for use of range resources. But it did not—and could not—establish priorities for how the range should be managed. Only BLM can do that, and BLM can do better when it has Congressional direction.

TIMBER

BACKGROUND

The conservation movement, one of the parents of environmentalism, originated around timbering. The widespread cutting of our virgin forests for timber—resulting in stripped hills, muddy streams, loss of soil, and floods—aroused a strong public determination to manage the public lands so as to preserve both land and water and the long-term timber yield of the forest.

The forest reserves were set apart from the vast undifferentiated lands of the public domain for these purposes. Established in 1891, enormously expanded during Theodore Roosevelt's Presidency, and renamed National Forests in 1907, the National Forest System today still counts timber among its chief purposes. The mandate of the U.S. Forest Service is to manage all renewable resources, including timber, on sustained yield bases, in accord with sound environmental practices, and in the best combination with the other purposes of the National Forests—watershed protection, wildlife and range protection, and outdoor recreation.

Supply and Demand

Some 754 million acres, one-third of the 2.3 billion acres of land in the United States, is forested. These lands vary from highly productive forest areas that are intensively managed for timber production to areas incapable of yielding industrial wood because of unfavorable climate, topography, elevation, or soils. About 500 million acres of forest land is now classed as commercial timberland—land available and suitable for growing continuous crops of wood as well as for other uses.[34]

Net timber growth has generally increased throughout the country since 1960, particularly softwood trees large enough for sawtimber in the South and hardwood sawtimber in the North. The latest decennial survey of U.S. forests showed that in 1970, net growth of eastern softwood timber exceeded removal by 48 percent, or 2.2 billion cubic feet. This fact indicates that eastern forests can support larger softwood timber harvests. In western forests removal exceeds growth. However, growth rates in western forests are increasing as old growth stands are replaced by younger stands.[35]

Timber now appears in reasonably good supply and has generally stayed abreast with demand, which rose 65 percent over the last 3 decades.[36] What of the future? In timber management, forecasts are of prime importance; trees that managers plant today will not be harvested for many years, often more than 50.

Forecasting is a tricky business that must take into account not only the resource but population trends, changing customs, shifts in income, and above all, price. Making allowances for the uncertainties of the future, the Forest Service forecasts for timber in the year 2000 are not reassuring. Demand is projected to increase more rapidly than supply from our native forests.

If timber prices remain stable in relation to other prices at the 1970 level, demand for wood will nearly double, rising from 12.7 billion cubic feet of roundwood in 1970 to 23 billion in 2000. Even if relative timber prices gradually rise at 1.5 percent per year (a likely possibility), demand is still forecast at 19 billion cubic feet in 2000.[37]

A mature "old growth" cedar tree is felled on Willamette National Forest, Oregon.

In the Forest Service's judgment, the supply of timber from the nation's forests will not grow that fast. Supply of softwood timber, assuming 1970 management practices and policies, is projected to increase 31 percent from 1970 to 2000, from 8.8 billion to 11.5 cubic feet.[38] Future supply problems seem most acute for softwood, the most commercially important of woods. But other forest products, such as high-grade hardwoods, are also expected to be in short supply.

It is possible that in time wood shortages may seriously affect economic growth, at least in its present pattern. Higher prices for timber would occur. One possibility is substitution of nonrenewable resources that require more energy to produce. Another may be intense pressure to diminish other uses of the public forest land in order to shift to more timber production.

Timber from the National Forests

How much timber can and should the National Forests yield? In 1974, softwood sawlog production in the National Forests was 11.6 billion board feet; in all other forests, it was 36.7 billion board feet.[39] Eighteen percent—some 92 million acres—of all the nation's commercial forest land is held in the National Forests. How this substantial holding is managed has a considerable effect on overall timber supplies.

In 1971, a blue ribbon Panel on Timber and the Environment, chaired by former Secretary of the Interior Fred A. Seaton, was appointed to advise the President on increasing the nation's timber supply to meet growing housing needs while protecting environmental quality. The central question reviewed by the panel was how rapidly

Logging in Six Rivers National Forest, California, contributes to the substantial timber yield from national forest land.

should the "old growth" stands of the National Forests be cut and replaced with new stands.[40]

The panel concluded that timber cutting could be substantially increased in western National Forests—for the four forests that it analyzed, the annual harvest should be 39 percent above that proposed by the Forest Service. It further recommended that the Forest Service revise its policies for setting allowable cuts, encourage more cutting of old growth stands in the National Forests, support a program of accelerated new growth, and recommend increased investments in the neighborhood of $200 million each year for forest development.[41]

There is evidence that National Forests could indeed produce more timber than they do. Forests owned by the commercial forest industry do grow more wood per acre.[42] There are three main reasons: the industry owns more productive lands, stands are younger and more vigorous, and the intensive forestry practices employed produce wood faster. These practices include growing stands of trees all of the same age; artificial planting (generally one species, establishing a monoculture); thinning; intensified protection from fires; control of competing vegetation by fire, chemical, and mechanical means; use of chemicals such as pesticides and fertilizers; and breeding of new genetic strains of "super" trees. (The Forest Service and others also employ these practices, but generally to a lesser extent.)

In 1970 the Public Land Law Review Commission recommended that "a statutory requirement that those public lands that are highly productive for timber be classified for timber production as the dominant use . . . ."[43] Environmentalists protested this concept of dominant use and the Forest Service has never accepted it. Dominant use could mean forgoing the opportunity to manage for several resources on the same area at the same time.

A crucial problem with intensive management in the National Forests is the long- and short-term ecological effects of such interference with the forest system. Monoculture raises questions that may never be fully answered. However, it is a biological axiom that the more complex and diverse a natural community, the greater is its stability.

A related question involves the impacts on wildlife of controlling underbrush, which competes with new growth of trees. Many forms of wildlife depend for sustenance on these "understory" plants. Fertilizer runoff into forest streams and lakes raises further questions—overnourishment from artificial fertilizer may interfere with the aquatic ecosystems.

These and many other problems require thorough examination to assess both short- and long-term consequences. Private forest landowners may use intensive forestry methods to hasten and increase output, but intelligent environmental safeguards should be applied. Public ownership of the National Forests offers the chance to manage an important share of the nation's timberland in a way reflecting consideration of other forest values and uses that is not often possible by private owners. Moreover, by law the public lands must be managed to meet a broad array of public objectives and goals.

Clearcutting

One management practice at the center of national attention and concern was clearcutting in the National Forests in the late 1960's and early 1970's. Under this approach, all trees on an area are cut; other practices leave at least some trees after logging. Many environmentalists expressed alarm at the size of areas that had been clearcut—in some places amounting to thousands of acres. Besides seeing dangers to water, soil, and wildlife from clearcutting, critics were appalled at the appearance of cutover areas. The Bitterroot Forest in Montana, Shoshone and Teton in Wyoming, and the Monongahela in West Virginia all became battlegrounds.[44]

In response to the criticism and following the mandate of NEPA, the Forest Service conducted a multidisciplinary review of its timber management activities, focusing on 30 major problems.[45] (The location, amount, and manner of the cutting are controlled by the

Forest Service, but the work is done by private companies under contract after competitive bidding.) Meanwhile, a Senate Subcommittee on Public Lands set guidelines on timber harvesting in a report entitled "Clearcutting on Federal Timberlands." [66]

The Forest Service's response to its own review and to the Senate report was an action plan which included the following principles:

Clearcutting should not be used on federal land areas

- Where soil is fragile or where slope or other watershed conditions are vulnerable
- Where there is no assurance that adequate restocking will take place within 5 years
- Where aesthetic values outweigh other considerations
- Where clearcutting is chosen only because it will give the highest dollar return.

On the other hand, clearcutting should be used only

- Where it is essential to accomplish multiple-use forest management objectives
- Where the size of clearcut areas is kept to the minimum to achieve these objectives
- Where clearcut blocks may be shaped and blended as much as possible with natural terrain.[67]

Private Forest Land

Intensive management is one way of increasing wood supply. Another is to add to forest lands. National Forests contain 18 percent of U.S. commercial forest land, and the forest industry owns another 14 percent, as Table 20 shows. Nearly 60 percent is small, privately owned tracts. These lands are an important potential source of wood in the future. However, according to Edward P. Cliff, retired Chief of the Forest Service, "Most of the 296 million acres [of private woodlots] are not poorly managed—they are in effect unmanaged." [68]

Changes in management level of these small private forest ownerships have occurred slowly because investments take a long time to reach fruition, are highly uncertain, and investment returns have not been high. Often the owner of a small tract may have a short-term or speculative interest, which is not conducive to good forestry practice.

There is a long history of federal efforts to provide technical forestry assistance through the states, including the Clarke-McNary Act of 1924 [69] and the Cooperative Forest Management Act of 1950.[70] The now defunct soil bank program included provisions to pay for tree planting. The Forestry Incentives Act of 1973 [71] authorized a program of federal cost sharing for timber culture practices to encourage small woodlot owners to manage their forest for timber production.

Table 20

Commercial Timberland and Growing Stock in the United States, 1970

Ownership	U.S. forests		Growing stock	
	Area, in thousands of acres	Percentage	Volume, in billions of cubic feet	Percentage
Public				
National Forest	91,924	18	217	34
Other public	44,196	9	68	10
BLM	4,762	1		
BIA	5,888	1		
Other federal	4,534	1		
State	21,423	4		
County and municipal	7,589	2		
Private				
Forest industry	67,341	14	100	15
Other private	296,236	59	264	41
Farm	131,135	26		
Miscellaneous	165,101	33		
Total	499,697	100	649	100

Source: U.S. Department of Agriculture, *The Outlook for Timber in the United States*, Forest Service Report No. 20 (Washington, D.C.: Government Printing Office, 1973), pp. 11, 32.

Air and Water Quality

Some forestry practices may have major effects on air and water quality. Forests are deliberately burned to eliminate underbrush, insects, and disease, to create clearings for wildlife, and to get rid of the residue from logging (slash) that might feed an uncontrolled fire.

The owner of this private loblolly pine plantation in Mississippi planted seedlings where natural reforestation did not take hold.

The Forest Service burned 735,000 acres in fiscal year 1974. Unfortunately, the burning emits pollutants, especially particulates. The volume of particle pollution from controlled fires in National Forests in fiscal year 1974 was 299,800 tons.[82]

The usual way of dealing with the problem is to burn only when weather conditions would minimize air pollution. But less burning is likely because the slash is becoming increasingly valuable commercially for pulp and particle board.

One of the major environmental problems involved in cutting timber is the effects on life in nearby streams. A 1973 Forest Service report on the effects of logging on fish in the Western United States and Canada found that beyond any doubt logging had deleterious effects on fish; some of the detrimental practices had ceased but others still continue.[83]

Poor logging practices can harm fish in several ways. Logging and the building of roads for logging can erode stream banks and allow sediments to clog the streams. Logging debris can stop the stream flow. Loss of tree cover can change the stream temperature winter and summer. Pesticides and fertilizers from intensive forest management may pollute the streams.

Good forest management can limit these adverse effects. For example, buffer strips of trees are often left uncut on stream borders. But just how wide the strip must be to protect the fish adequately is not well-understood. Nor is it known how long lasting is the disruption of fish from nearby logging or how much wood production it is reasonable to give up for what may be a temporary impact on fisheries.

To comply with the Federal Water Pollution Control Act,[84] major forestry programs on both public and private lands must attempt to control water pollution from forestry practices. Silviculture is defined as a nonpoint source of pollution in the act.

EVENTS OF THE PAST YEAR

A major effort to inventory the nation's renewable resources and plan for their use is mandated by the Forest and Rangeland Renewable Resources Planning Act of 1974.[85] By the end of 1975, the Agriculture Department must have completed a comprehensive assessment of renewable resources along with a long-term program for protecting and developing the resources managed by the Forest Service.

The Forest Service is also engaged in reviewing its policy to sustain timber yields over time as well as its method for calculating allowable cut for a particular year. The Forest Service had taken a conservative stance on allowable cut, refusing to base it on potential increases in yield from new management practices, arguing that too many biological, management, and fiscal risks are involved.

In the past year the Forest Service began to test a more liberal policy on one major timber-producing forest, the Gifford Pinchot National Forest in Washington. There a long-term commitment of funds has been made to finance an accelerated program of reproduction and intensive timber culture.[86] The allowable harvest rate is based on the assumption that the work will be accomplished in a timely manner. Controls have been established to reduce the harvest rate if planned work falls behind schedule. If the test proves successful, other Pacific Northwest National Forests are likely to follow suit.

Control of water pollution from logging and the roadbuilding that goes with it is the subject of a 3-year EPA study of forest practice in the Pacific Northwest. Portions of the study released this year proposed guidelines for harvesting, replanting, and roadbuilding in order to prevent or to minimize pollution. The third phase of the study, to be completed next year, will deal with the effects on water quality of chemicals used in forest management.[87]

The Environmental Protection Agency also commissioned a study of air and water pollution from forestry practices in Flathead National Forest, Montana, with the purpose of identifying and controlling nonpoint sources of pollution.[88] The study noted that mineral soil, organic matter, and temperature change are the major pollutants from logging and added that chemicals will be an increasing source of pollution if they escape careful control. "There is a strong positive correlation between the level of timber production and the amount of pollution," the study concluded. It found a serious lack of baseline data, which are necessary to evaluate pollution control measures.

The National Forest Products Association (NFPA), an industry group, argues that the principal authority for regulating forest water quality should be state forest practice laws.[89] EPA takes the same view. Both EPA and NFPA have developed model state laws which have been under discussion during the year. Because existing legislation has dealt primarily with replanting forests after harvests, protection of water quality would expand the scope of state forestry practice laws.

ISSUES TO WATCH FOR

Allowable Cut

The Forest Service has been urged by the Seaton panel, the Public Land Law Review Commission, and the industry to raise allowable cuts in the National Forests. On the other side, several citizen groups are concerned that the allowable cut is too high to maintain sustained yields.

Much of the argument over allowable cut boils down to a policy decision on what foresters call "even flow." This is a particular issue in the National Forests of the Pacific Northwest, which are characterized by old growth, stands of mature and overmature trees. After full maturity, trees grow little or not at all and mortality is heavy. Cutting may result in greater growth because the new replacement trees grow much faster than the older trees. But if the old trees are harvested too rapidly, a time gap develops when little harvesting can take place because the second growth trees are not yet at the cutting stage. Under such a scenario, the flow of timber is uneven.

Conservative management says to move slowly on cutting the old trees and keep the flow of timber fairly even. A University of Montana study prepared for EPA recently urged a conservative harvest policy because projections of timber growth are not entirely reliable.[60] And the impacts of rapid cutting of old growth, versus other kinds of management, are not yet well-understood.

Another factor that determines allowable cut is suitability of an area to commercial logging. This depends upon the topography, the quality of the soil and the likelihood that it will erode, the density and kind of timber, and necessary safeguards to protect other forest values, such as buffer strips to protect stream quality. New technology—logging by helicopter is one—may open up isolated areas that were previously unsuitable for logging. By reducing the need for roads in sensitive areas, helicopters may make more areas available for timber production while protecting the environment.

Nonpoint Pollution from Forest Lands

How to achieve clean water goals in forest lands is an unresolved issue of considerable consequence. EPA has proposed forest practices legislation.[61] It is not clear how compliance with such a law would relieve timber operators or landowners from further responsibility for meeting water quality standards. The relationship of practices and standards needs to be more closely understood. Lack of baseline data, inherent changes in background and natural pollutants, and the problems of monitoring large, remote areas will continue to make it difficult to use a standards approach to deal with nonpoint pollution.

Intensive Timber Management

We are learning how to manage a greater forest yield faster perhaps than we are learning about the consequences and impacts of the new practices. Are successful industrial forest practices desirable and suitable on multiple use public forests? Should we reach for the highest possible yield, limited only by technical capability and capital investments? In the past, these questions were more hypothetical than real because of the high cost of new methods and because of inexperience. Today intensive forestry methods are more economical, and experience has shown that they work—although their full environmental consequences are still unknown. The Resource

Planning Act offers an opportunity to make rational decisions on the best methods for managing the forests that are ours.

MINING

BACKGROUND

Managing all the resources on our public lands presents common problems of conflicts among uses and users. Mining has a special problem as well. The laws that govern it—the Mining Law of 1872 and the Mineral Leasing Act of 1920—in effect limit the federal government's control over mineral development on the land that it owns.

Mining Laws for Public Lands

The Mining Law of 1872 [63] reflected the spirit of the times, that the government should turn its lands over as rapidly as it could to private owners who would put it to profitable use and encourage the

The after effects of gold dredging are evident in Goldwater Creek, Plumas National Forest, California.

exploration and development of mineral resources on the public land. This law still applies to gold and silver, to iron, copper, lead, bauxite, zinc, and tungsten, all the hard rock minerals. It also applies to uranium, the basic nuclear fuel. The law gave away the mineral to whoever found it and also made it easy for the miner to take possession of the land.

The "new" mining law, the Minerals Leasing Act of 1920,[63] applies to coal, onshore oil and gas, oil shale, phosphates, potassium, sodium, and asphalt. It reflects a certain change in outlook, recognizing that resources on the public lands belong to all the people and that it is desirable for the public to receive some return for its property. Under this law, the federal government retains title to the land and leases (in effect, sells) the mineral to private parties, with provision for royalties shared by federal and state governments when the mineral is produced. Mining issues concerned with coal and oil are discussed in an earlier section on energy.

The Mining Law of 1872 formalized the customs and procedures established in the early mining camps. For the minerals covered, anyone making a valid discovery can stake a claim by filing a claim notice at the local county courthouse. There is no requirement to file claims with the federal government, which makes it difficult to monitor day-to-day use of publicly owned land.

To maintain rights to the claim, the miner must show evidence of at least $100 worth of work at the claim site each year. The annual sum of $100 required for this "assessment" work is the same today as it was in 1872. States set the standards for assessment work, and they vary, but this modest requirement is basically all that is necessary to maintain the claim and to mine on federal public lands. Most National Park units are exempt from mining; Death Valley National Monument and five others are the exceptions. Mining is restricted in most Wildlife Refuges and is banned in a few. Except for land that has been withdrawn for purposes like campgrounds and administration, all other public lands, including Wilderness Areas, are still open to mining under the 1872 law. New claims on wilderness lands must cease by 1984, but mining valid claims may continue.[64] Mining roads are an exception to the strict ban on roads in Wilderness Areas. Access to claim sites by road is permitted, although restrictions are stringent.

Under the 1872 law miners with a valid claim to minerals under the public lands may gain full title (a patent, which is a claim the title to which has passed into private ownership) to the land itself. This requires proof that they have spent $500 in labor or money working a claim and that they have discovered a valuable mineral deposit (a "valuable" deposit is defined as economically worthwhile to pursue). The fee for title is the same as it was in 1872—$5 per acre for lode claims and $2.50 for placer claims.

The Mineral Leasing Act of 1920 provides several leasing methods, depending on the mineral and how much is known about the deposit. If the government knows enough about a deposit to assess its value, it may be leased by competitive bidding. Where the size and value of a deposit are not known, a prospector may obtain a special prospecting permit that entitles him to a preference right lease for production if he discovers a valuable deposit.

Neither of these basic mining laws allows the federal government much say in the pace and timing of mineral development on public lands. Economic and market conditions determine in what order industry will develop deposits or, indeed, if they will be developed at all. Under the 1872 law, the miner in effect owns the resource to do as he will with it. Most leases under the 1920 law are for 10–20 years, with option for renewal. Coal is leased indefinitely with provision for renegotiation every 20 years. Upon renewal or renegotiation, new stipulations may be added and royalties changed.

Leaseholders have not been obliged to produce in order to keep a lease, although oil and gas are now an exception. But preference right leasing usually means that the leaseholder may go ahead with production—even where there may be good environmental reason to call a halt—unless the government sues to cancel the lease.

Environmental protection is simply left out of both mining laws. Under the 1872 law, the miners may stake a claim anywhere on public lands that are open to mining entry; they choose the spot. Once they file a claim, the resource is theirs and they may mine it by whatever means they choose, with minimal federal government control.

The Minerals Leasing Act of 1920 contains no environmental protection features, but regulations could build them into the operation of the law. New regulations in the making would increase environmental protection for mining federal coal. Present standards for approving miners' operating plans and for rehabilitating the land after mining is finished are general. The land management agencies write requirements for reclamation on a case-by-case basis, and stipulations vary for individual leases. They have improved over time, but some aspects of the requirements are uneven and sometimes requirements are negligible.

Mineral Production

U.S. dependence on foreign mineral supplies plus shortages and high prices have focused attention on the mineral potential of our public lands and on the laws affecting extraction. Public lands are a substantial source of both fuel and nonfuel minerals (see the section on energy for a discussion of fuel minerals). In 1974, 45 percent of U.S. sodium production came from federal lands, 79 percent of potash, and 14 percent of phosphates.[60] The majority of the nation's phosphate resources are on federal lands in the intermountain basin, chiefly in Idaho, but most current production comes from the Southeast, especially Florida and North Carolina.

Open pit copper mines have been developed without any consistent environmental regulation.

The United States appears headed for still greater dependence on foreign sources of some minerals than it is today. A Government Accounting Office study of the 1872 mining law projected U.S. production of some nonfuel minerals in relation to demand for the year 2000.[44] The share of demand filled by domestic production is expected to drop precipitously for some minerals. The ratio for selected minerals is shown on Table 21.

Table 21

Domestic Mineral Production as a Percentage of U.S. Demand

Minerals	Percentage	
	1971	2000
Aluminum	11.4	2.0
Copper	93.5	45.6
Gold	22.8	7.3
Iron	72.0	37.3
Lead	61.2	45.0
Silver	40.9	21.0
Tungsten	62.0	3.6
Zinc	37.0	17.8
Uranium	96.9	39.5

Source: General Accounting Office, *Report to the Congress: Modernization of the 1872 Mining Law Needed to Encourage Domestic Mineral Production, Protect the Environment, and Improve Public Land Management*, Report # B-118678 (Washington, D.C., 1974), p. 7.

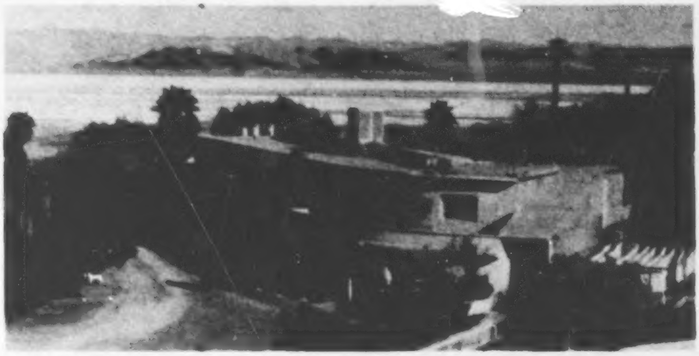
EVENTS OF THE PAST YEAR

The General Accounting Office July 1974 report on the 1872 Mining Law posed the questions of whether the law encourages development of mineral resources, results in effective management and use of the land, protects the environment, and responds adequately to shortages of domestically produced mineral ores.

In the course of the study, GAO visited 240 mining claims and 93 patents issued within the last 25 years in four Western states (Arizona, California, Colorado, and Wyoming). In 239 of 240 no mining was taking place, and on 237 there was no evidence that it ever had. Of 93 patents visited, 7 were being mined, 66 were not being used, and 20 were in use for purposes that had nothing to do with mining. There was no evidence that minerals had ever been extracted on 74 of the 93 patents. GAO concluded that the 1872 law does not foster much mineral development, nor does it offer the government any opportunity "to induce mining of these lands." [47]

Should the government wish to clear invalid claims not being mined, the procedure is lengthy and costly. In 1968 the Bureau of Land Management began an effort to cancel mining claims in Colorado, Wyoming, and Utah to make the land available for oil shale leasing. As of February 1974, BLM had identified 56,000 claims in the area; only 5,600 claims had been canceled.[48] GAO recommended that before claims are recorded, claimants should have to show discovery of valuable minerals, and further, that claims should be recorded with the Interior Department rather than scattered in county offices.

The GAO found considerable environmental damage from operations under the 1872 law, with little or no provision for rehabilitation. The Wyoming BLM office estimated that it would cost $4 million to correct the damage done by prospecting on 17.5 million acres of



A claimholder established a 12,000-acre complex, including a health resort and this 20-unit hotel, on public land mining claims in San Bernardino County, California.

public lands. One cause of environmental damage is the annual assessment work that the law requires to keep claims alive. In Arizona, 3,700 cubic yards of dirt had been scraped off 214 claim sites to meet the law's assessment requirements. On 19 patent sites, damage from dumps, open shafts, and access roads was reported.

The four states visited were more successful in obtaining compensation for minerals recovered from state-owned lands than was the federal government for federally owned public lands. All four had adopted leasing systems for exploration and development that provided for rentals and royalties.[69] With its location-patent system under the 1872 law, the federal government collected no more than the amounts paid for patents.

GAO recommended establishing a leasing system for the minerals and lands currently covered by the 1872 law. In order to assure protection of the environment, GAO recommended that the new system require exploration plans that would state in detail how exploration would be done and what measures would be taken to minimize damage and to reclaim the land.

Such a proposal to reform the mining laws was embodied in an Administration bill in the 93d Congress.[70] It would cover in one law all mineral prospecting, exploration, and development on the public lands. Most significantly, the revised law would set up a leasing system; no lands would be patented or sold. Most leasing would be discretionary. Preference right leasing, which almost automatically gives prospectors the right to produce once they have a permit to prospect, would be limited to hard rock minerals. Under this system the federal government would consider the environmental impacts of a mining proposal before mining began, weigh the alternatives, and write in protective requirements.

In a recent effort to deal with some of these problems, in September 1974 the Forest Service issued regulations which require prospectors to give notification before substantially disturbing the land's surface.[71] This requirement gives the Forest Service an opportunity to confer with the prospector about minimizing disturbance. Further, the miners are required to develop an operating plan in consultation with the Forest Service before beginning mining operations.

Current lease applications to mine phosphates in Florida's Osceola National Forest illustrate the problems posed by the preference rights leasing system of the 1920 Minerals Leasing Act. Today's pressure to develop this resource reflects the rapid change in the world phosphate situation over the last few years. An essential fertilizer, phosphates are very high priced.

There is no world shortage. Morocco, with vast reserves, enjoys as commanding a position in the possession of phosphate as the Persian Gulf countries do in oil. She is currently using the position to demand and get very high prices. Other countries' deposits, once subeconomic, have suddenly become worth mining.

This is the background for the proposal to mine thousands of acres of freshwater wetlands and forest in the Osceola National Forest. As long ago as 1969, the Kerr-McGee Chemical Corporation filed an application for a prospecting permit for phosphates in Osceola. The Forest Service granted the permit and subsequently 90 more to four companies between 1969 and 1972.

The companies have applied for preference right leasing, which would allow them to begin production. However, the Secretary of the Interior has delayed action, pending the outcome of environmental and economic studies. And Florida is suing to stop issuance of the leases.[72]

The total estimated phosphate reserve on the Osceola National Forest is 120 million tons (U.S. annual producton is 43 million tons and consumption is 22 million tons [73]). The resource here is clearly substantial. In its comments on the environmental impact statement, the Environmental Protection Agency analyzed a number of significant problems deriving from the development proposal and concluded that it was "unsatisfactory from the standpoint of environmental quality and public welfare." [74] The mining would permanently destroy 28,000 acres, 40 percent of this forest's swamplands, and would remove 9,000 acres from timber production. Osceola National Forest harbors a fragile ecosystem. Its wetlands are habitat for several endangered species in an area where habitat for them is already cramped. Another problem is that mining would expose radioactive materials, which might then pollute the water source for surrounding communities.[75]

In mid-1975 the situation was unresolved. Because of the importance of this case and opposition by the state of Florida, EPA, and others to mining, the preference right leases had not been granted. In less celebrated cases, even when environmental damage may loom large, there is little option to delay or to deny leases once prospecting permits have been granted.

ISSUES TO WATCH FOR

Proposals for reform of the public lands mining laws are likely to continue. The Office of Technology Assessment is beginning an analysis of institutional constraints and incentives affecting mining on federal lands.[76] The study will cover 15 fuel and hard rock minerals thought to exist in large quantities on public lands in the West. It will also assess state regulatory influences on mining in Alaska, Colorado, and Wyoming.

Findings from the OTA assessment may well be incorporated in bills to change mining law. There is still support for the 1872 law, as evidenced by industry backing of a bill in the 93d Congress,[77] which would have extended the location-patent system of the old law to more recently acquired public lands (not part of the original public domain) where it does not now apply.

The Liberty open pit copper mine in Ruth, Nevada, is over 1 mile long, five-eights of a mile wide, and 800 feet deep.

The most serious problems with the present laws are these:

- Lack of fair return to the public treasury for resources that the public owns
- Lack of adequate environmental protection of federal lands
- Lack of an adequate mechanism to achieve needed production of minerals
- Fragmented administration and lack of uniform standards and regulations
- Lack of provision for weighing mineral values with other resource values
- Lack of sufficient discretion for responsible federal officials to determine areas to develop and timing of development.

OUTDOOR RECREATION

BACKGROUND

The activities that people enjoy out of doors range from backpacking in wilderness solitude to tearing across miles of desert in a dunebuggy. Most types of outdoor enjoyment may be found on the public lands.

Each of the public lands systems has something to offer for recreation, but their roles differ. Outdoor recreation is one of the five major

Visitors use the public lands for a full range of outdoor activities. Here, hikers enjoy a quiet moment on the trail in Flathead National Forest, Montana, and a dune buggy kicks up sand in a California desert.

uses specified by the Congress for National Forests. And there recreation covers a wide variety of activities—camping and hiking, fishing and hunting, skiing and boating, birdwatching, and mountain climbing.

The National Wildlife Refuges are also open to varying degrees of public use. Observing and photographing wildlife are popular, and so are picnicking, fishing, and swimming. Some kinds of hunting are permitted in many Wildlife Refuges (170 of the 367 refuges were open to hunting in 1975).[78] Recreation is limited to areas where it does not interfere with the primary function of the refuge to protect and propagate wildlife.

National Parks are principally for preservation, but some kinds of recreation were always intended as a part of their enjoyment by the public. No one has better stated the purposes of the National Parks than Frederick Law Olmsted, a great pioneer in park planning, when in 1916 his words became National Park policy: "To conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner as will leave them unimpaired for the enjoyment of future generations."[79]

There was a time 40 years later when enjoyment seemed about to displace preservation. Park policy seemed to be encouraging people

Preservation of such natural wonders as the Grand Canyon of the Yellowstone is a prime purpose of the National Parks.

to enjoy their National Parks to death. The early parks were mainly in the West and use was promoted by railroads and the automobile. Following World War II, park facilities were generally inadequate to accommodate increasing numbers of visitors. To meet the perceived needs, the Park Service launched the 10-year "Mission 66" program in 1956, to update, improve, and increase facilities—roads, cabins, campgrounds, restaurants—for people to drive, park, eat, and sleep. "Parks are for people" was a popular sentiment. "It's no good having beautiful parks if the public can't get into them and see them." [80]

By the end of the program, it was clear that in the face of ever increasing use, the parks could not meet visitor use demand. The effect of drawing more people and cars to the parks and accommodating both was to degrade and sometimes even destroy what the people had set out to see. Traffic congestion, noise, and crowding began to affect the quality of the park experience for many visitors. Continued expansion of facilities also threatened the integrity of the features which the parks were established to preserve.[81]

National Park Service policy has now restored preservation of natural and historic features to first place.[82] In recent years the Service has recommended large amounts of parkland for preservation as wilderness. The parks will of course still welcome visitors, but accommodations will be planned with preservation in mind. There are parts of the Park System, including the National Seashores and reservoir areas, where recreation is a most important use. Even here, however, preservation is high priority. Further, public transportation has replaced or reduced reliance on the private automobile in crowded portions of several parks.

The least-known but by far largest of the public lands are the national resource lands of the public domain administered by the Bureau of Land Management. In principle there is no reason why some of these lands cannot accommodate many of the same outdoor activities as other public lands. In practice their little-known existence often means that they are not used for recreation at all.

Much of the land is in scattered parcels, public ownership is checkered with private holdings, and many boundaries are unmarked. It is little wonder that few people realize that national resource lands are available for recreation. In the Western states most are arid or semiarid—low desert or rangelands. Patrolled infrequently or not at all, they attract motorcycles, dunebuggies, and other offroad vehicles. In fact, BLM figures that one-half of all offroad vehicle use in the United States takes place on the unreserved lands of the public domain, and half of that is in southern California deserts.

Besides the outdoor recreation use of the nation's public land systems, there is also heavy water-oriented recreation use of reservoirs built by the Corps of Engineers, the TVA, and the Bureau of Reclamation.

Figure 12 illustrates the dramatic change in use of public lands for recreation after World War II.

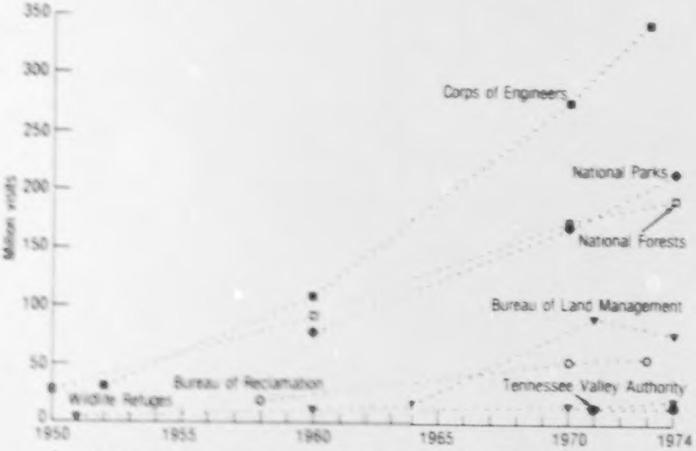
One-half of all offroad vehicle use takes place on BLM-managed public lands, much of it in southern California desert.

The potential for conflict between different kinds of recreation and between recreation and other uses always exists on the public lands. Winter sports development, for example, displaces quieter, more dispersed, less disruptive activities.

The Mineral King development proposed for Sequoia National Forest in California is a case in point. Responding to a huge demand

Figure 12

Recreational Use of Public Lands, 1950-74[1]



[1] In 1965 the Forest Service changed its reporting system to visitor days. A visitor day aggregates 12 person-hours.

The National Park Service defines a visit as the entry of any person into an area administered by the NPS such that that person makes some use of the services or facilities therein.

The Bureau of Reclamation data are in visitor days. A visitor day is a significant amount of time spent by one individual at a particular activity during a 24-hour period.

for quality winter sports in populous southern California, the Forest Service chose a site near Los Angeles that was good for skiing and asked for bids to develop the spot. The Disney Corporation submitted the winning bid, but the Sierra Club brought suit against the Forest Service to stop the development.[83]

The issue has not yet been resolved. Meanwhile, the Forest Service has prepared an EIS on a scaled-down proposal.[84] Mineral King well illustrates the issue of recreational development for the pleasure of tens of thousands of people every year versus the value of an undisturbed naturalness for fewer visitors.

Another conflict that sometimes occurs is between protection of public lands and recreational development on adjacent private lands. The National Parks, Forests, and Wildlife Refuges are under stress from private development, either on private parcels within public lands boundaries or on lands outside.

A common problem is vacation homes within or adjacent to the public land boundaries. Other sorts of development—mining, urban growth, amusement parks—can also lower the value of public lands nearby. Intrusions like the 307-foot observation tower overlooking Gettysburg National Military Park can destroy the character of a historical place. And it is generally expensive or complicated to resolve conflicts. After a struggle involving the Governor of Pensylvania, two Secretaries of the Interior, and scores of historians and preservationists, the promoter reduced the tower height by 13 feet. But without a zoning ordinance the county was unable to stop construction.[85]

One possible solution to the conflicts or pressures is simply to buy land under development pressure and add it to the public lands. The chief source of funds for buying public recreation land is the

Intensive recreational use such as this ski development in Inyo National Forest, California, displaces quieter, more dispersed use.

Land and Water Conservation Fund;[86] since 1965, it has added 1.4 million acres to the federal systems and 1.3 million acres to state holdings.[87] But generally public land acquisition is not the solution for developments with adverse impacts on the public lands. Other means of protection must be found. Each of the public land management agencies has begun efforts toward better coordination of land use policies with nearby private land uses.

EVENTS OF THE PAST YEAR

National Park Policies

During the year the National Park Service has taken a hard look at its policies for the three categories of parks that it administers: national, historical, and recreational. The policies were unified for better, more consistent guidance for Park Service personnel and in recognition that the same priorities of purpose apply to all. Many of the extensive natural parks contain historical sites. Similarly, there are outstanding natural features in the recreational parks which need protection.

Preservation is the keystone of the new policy in all National Parks. Over half the 31 million acres in the entire National Park System is proposed as permanent wilderness. For the rest, park authorities are testing mass transportation systems to lessen the ill effect of cars. Trailer parks and campgrounds are deemphasized. Incompatible uses, such as a ski area at Rocky Mountain National Park, will be removed. Some park plans call for moving visitor facilities away from the parks' major attractions and locating them nearby on National Forest or other public or private lands.

Another important feature of the policy is limitation of visitor use. When necessary, the Park Service will regulate the amount, kind, time, and place of visitor use. The Park Service is now studying the limits that may be required.

Offroad Vehicles

ORV's on public lands are known to conflict both with other kinds of recreation and with efforts to preserve the natural character of the land. That conflict was carefully studied in BLM's environmental impact statement on a desert motorcycle race.

The Barstow to Las Vegas Hare and Hound motorcycle race has become something of a Thanksgiving Day tradition in the Southwest. The 1974 race was the eighth. Advertised as the world's largest, covering 155 miles of open desert, it attracted 3,000 competitors and was attended by 9,000 spectators and pit crew members. Much of the land that the race covered is in the public domain, held and managed by the Bureau of Land Management.[88]

The 1974 Thanksgiving Day "Hare and Hound" motorcycle race from Barstow to Las Vegas attracted 3,000 competitors and 9,000 spectators. Much of the 155-mile course traversed public land.

BLM monitored the race closely. Impacts on air quality were less than anticipated. But the race affected 25 percent more land than the 1973 race, damaging more soil and vegetation than expected. Attempts to protect Indian archeological sites along the way proved less than successful because racers did not stay on course, but also because the course covered previously undiscovered sites, which became known only after the damage was done.[89]

The only public lands from which ORV's are flatly banned are Wilderness Areas. In 1972, Executive Order 11644 directed agencies to control use of ORV's on public lands in order to protect the land, provide for the safety of other users, and minimize conflicts among users.[90] However, the approach varies greatly among management systems.

The National Park Service and the Fish and Wildlife Service closed all the parks and refuges to ORV's pending review. As of 1975, only 12 of the 367 Wildlife Refuges permit ORV use.[91] In the National Parks, ORV's are confined to roads and designated trails.

The Forest Service and BLM were faced with a greater challenge in carrying out the order, for they administer very large acreages. At the time of the order, their attitude was permissive and ORV's were using their lands rather freely. The response of the Forest Service was to accelerate their land use planning in order to study the potential effects of ORV use and designated areas and trails where use would be allowed, restricted or prohibited. Pending completion of these reviews, the status quo of ORV use was maintained. So far, 30 million of the 187 million acres of National Forest has been closed to ORV use (half of this is out of bounds because it is wilderness or primitive area). BLM's approach was to declare nearly all its land open for ORV's until decisions are made, area by area, to bar or allow them. This approach has now been declared in violation of the Executive order.

In *National Wildlife Federation* v. *Morton,* the court found that designating land as open to ORV use until an explicit decision is made to close it biases policy in favor of ORV use.[92] The court found that an official "open" designation creates a "subtle, but nevertheless real, initial presumption in favor of ORV use." BLM was ordered to rewrite its regulations.

The Tennessee Valley Authority has taken a constructive approach to ORV use in the 170,000-acre "Land Between the Lakes," which it manages. Designating one section for ORV use and putting the rest out of bounds, TVA finds this arrangement easier than trying to confine ORV use to roads and trails, which are difficult to police. Designated for ORV use was a carefully chosen place where adverse impacts were likely to be minimal. TVA reports damage to less than 1 percent of that land.

New Federal Areas

During 1974, the Congress authorized 12 areas for addition to the National Park System (see Table 22); it also authorized extension of Siuslaw National Forest in Oregon to include the Cascade Head Scenic Research Area.[93] The 8,910-acre area, within the existing National Forest and adjacent to it, includes estuaries and wetlands of the Salmon River. Rich in fish and wildlife, the area is within easy access of the populous northwest coast.

ISSUES TO WATCH FOR

Land Acquisition

Within their boundaries, the National Parks, Forests, and Wildlife Refuges have patches of privately owned land—inholdings—which they are authorized to acquire as they can. Further, the Congress has authorized other additions as well as entirely new parks and refuges. In the past year alone, the Congress directed the National Park Service to acquire $254 million worth of land within 6 years for three new parks, the Cuyahoga Valley National Recreation Area and the Big Thicket and Big Cypress National Preserves.[94]

Table 22

Additions to the National Park System, July 1, 1974, to June 30, 1975

Park	Acres	Location	Status/Public Law
Big Cypress National Preserve	570,000	Florida	Established 10/11/74 P.L. 93–440
Big Thicket National Preserve	84,550	Texas	Established 10/11/74 P.L. 93–439
Boston National Historic Park	35	Massachusetts	Established 10/1/74 P.L. 93–431
Canaveral National Seashore	67,500	Florida	Established 1/3/75 P.L. 93–626
Clara Barton National Historic Site	1	Maryland	Established 10/26/74 P.L. 93–486
Cuyahoga Valley National Recreation Area	29,112	Ohio	Established 12/27/74 P.L. 93–555
John Day Fossil Beds National Monument	14,402	Oregon	Established 10/26/74 P.L. 93–486
Knife River Indian Villages National Historic Site	1,292	North Dakota	Established 10/26/74 P.L. 93–486
Martin Van Buren National Historic Site	42	New York	Established 10/26/74 P.L. 93–486
Sewall-Belmont House National Historic Site	4	Washington, D.C.	Established 10/26/74 P.L. 93–486
Springfield Armory National Historic Site	55	Massachusetts	Established 10/26/74 P.L. 93–486
Tuskegee Institute National Historic Site	70	Alabama	Established 10/26/74 P.L. 93–486

Public land acquisition is a slow, tedious process. Rising land values compound the problem. The presence or possibility of a National Park, Forest, or Wildlife Refuge tends to boost local land values so that adjacent private lands and inholdings become increasingly expensive.

The Land and Water Conservation Fund Act of 1965, administered by the Bureau of Outdoor Recreation, is now authorized at $300 million annually through fiscal year 1990. After deducting administrative costs, 60 percent usually goes to the states and 40 percent to the federal land management agencies. The Park Service generally receives about $75 million annually. In fiscal 1975, $30.9 million went to the Forest Service, $9.5 million to the Fish and Wildlife Service, and $500,000 to the Bureau of Land Management.[85]

The money problem for acquiring land is hardly unique to the agencies that manage public lands for recreation. This worthy objective must stand in line with many others for federal funds. The amount of land that will be acquired by the federal government for recreation purposes is an increasingly difficult one to resolve.

Urban Parks

New urban parks are a part of the land acquisition challenge. Two that are already a part of the National Park System, the Golden Gate

National Recreation Area in San Francisco and the Gateway National Recreation Area in New York, are immensely popular. The 93d Congress created a third—the Cuyahoga Valley National Recreation Area near Cleveland is authorized but not yet acquired.

The special value of these urban parks is that they serve the city poor, the part of our society without the means to travel to remote areas. More people can use urban parks because they are located where the people are. And it is a matter of civic pride for a city to have a National Park, run by the prestigious National Park Service with its tradition of information, education, and public service.

Until now urban parks have been broadly supported by conservation groups, but money limitations led to second thoughts. Buying land in or near cities could consume a large share of Park Service funds. The 29,000-acre Cuyahoga Recreation Area alone is estimated to cost $34.5 million. In fiscal year 1975, the Park Service spent $25.3 million on urban parkland, compared to $45.9 million for nonurban park additions.

The National Parks and Conservation Association, a previous supporter of urban parks, now argues that the National Park Service was "designed primarily for the protection of the great scenic parks of America and could be weighted down by the addition of urban units requiring a different managerial perspective." [illegible]

The association has suggested that the state share of the Land and Water Conservation Fund might be used for acquiring urban parks. Most now goes for recreation development. Using the money for purchase of parks, especially costly urban parks, means of course that there would be less money for development. Some fundamental choices related to the role and composition of the National Park System appear to be inescapable.

National Park Service Concession Policies

For a long time the public has been concerned about the power of private concessions' supplying food, lodging, gas, and souvenirs in National Parks. Concern reached a climax last year with the Yosemite National Park–Music Corporation of America arrangement. MCA integrated the great National Park into its amusement empire by using it as the background for a television adventure series; further, MCA proposed to build a big convention center in Yosemite.

Last year, following considerable debate and criticism, the Interior Department rejected a master plan that embodied many MCA concepts, and a new plan is now under development. MCA still has the concession but will have to conform to the plan that the Park Service is developing.

The episode points up a situation which has led some interested citizens to urge a revamping of the concession system. The purpose of concessions is to provide the services that visitors need, not to exploit the parks for commercial interests. The means of assuring that

Concessioners proposed to build a big convention center in the magnificent natural setting of Yosemite National Park, California.

this purpose is fulfilled will be a subject of public debate during the coming year.

WILD AREAS

BACKGROUND

For most of history, human beings have feared the wilderness, seeing it as an enemy to be conquered or destroyed. The vast, seemingly unending eastern forests of colonial America had little appeal to the 17th century mind, bred on classical order. Visiting the Berkshire County region of Massachusetts in 1694, the Rev. Benjamin Wadsworth described it as "a hideous howling wilderness" [97]—an opinion widely shared by Americans for years thereafter.

By the early 19th century, the Romantic Movement had changed perceptions of the wilderness. Thoreau, Emerson, Parkman, Bartram, Audubon, and many others celebrated the unique value of wilderness. Later, John Muir and others in the West devoted their lives to protecting wilderness values on the public domain.

Early in this century, Aldo Leopold, Robert Marshall, and Arthur Carhart of the U.S. Forest Service pioneered the concept of wilder-

The Gila Wilderness, Gila National Forest, New Mexico, was established in 1924 as the nation's first Wilderness Area.

ness preservation. Subsequently, a number of National Forest wilderness, wild, and primitive areas were set aside for special protection. A unique part of the Superior National Forest of Northern Minnesota was given the special designation of Canoe Area.

The Gila Wilderness, a 750,000-acre preserve in New Mexico, was the first wilderness to be established by the Forest Service. This was in 1924.[98] During the next 40 years, millions more acres were added to the Forest Service wilderness system.

As the Forest Service system evolved, no timbering whatever was allowed in wilderness and wild areas, virtually no roads were permitted, and manmade structures were limited. Grazing was allowed, and under terms of the 1872 Mining Law the wilderness was still open to mining claims, with reasonable road access to mining sites.[99] At first there were fewer restrictions on areas designated primitive, but eventually the same rules applied to all. When the Congress established a National Wilderness Preservation System in 1964,[100] the Forest Service had by administrative action already set aside and protected 14.6 million acres of national forest as wilderness, wild, primitive, or canoe areas.

The National Wilderness Preservation System

It took 8 years of effort and compromise for the Congress to legislate a permanent wilderness preservation system. The first bill was introduced in 1956.[101] By 1964, there was finally enough agreement between advocates for wilderness and proponents of other uses that the Congress was able to pass the Wilderness Preservation System Act. The policy of the act was to save some lands forever from "expanding settlement and growing mechanization" and "to secure for the American people of present and future generations the benefits of an enduring resource of wilderness." [102]

The act immediately designated as permanent wilderness 54 National Forest wilderness, wild, and canoe areas—some 9.1 million acres.[103] Roads were generally barred forever. There may be no timbering, no commerce, no manmade structures, and no motor vehicles (except a bare minimum for administration and emergencies and a few specific exceptions provided in the act). Grazing is permitted, but only where it was already established when the law was enacted; it is further limited by the restriction on manmade structures.

Marks of the compromises needed to pass the law show in the mining provisions. Through 1983, claims may still be filed under the Mining Law of 1872. Afterward, no more claims may be filed, but existing valid rights will still be honored.[104]

Decisions on how much additional acreage to include in the permanent wilderness system were postponed for future Congresses to deal with. The act required that all areas classified as "primitive" by the Forest Service must be reviewed for possible inclusion; they amounted to 5.5 million acres.[105] Wild roadless areas on public lands other than the National Forests were also singled out for a mandatory review that was to take place in stages over a 10-year period.

During the 10 years, the Congress added 71 new areas to the Wilderness System, vastly increasing its geographic, biological, and physiographic diversity.[106] Our southern swamps, islands, subtropics, the Great Plains, and Alaska are now represented. In 1964, no more than four Wilderness Areas were east of the middle of the country (the 100th meridian)—they were in New Hampshire, North Carolina, and Minnesota. Today, 22 states in the eastern half of the nation have wildernesses, as do Alaska and 10 out of 11 Rocky Mountain and far west states.

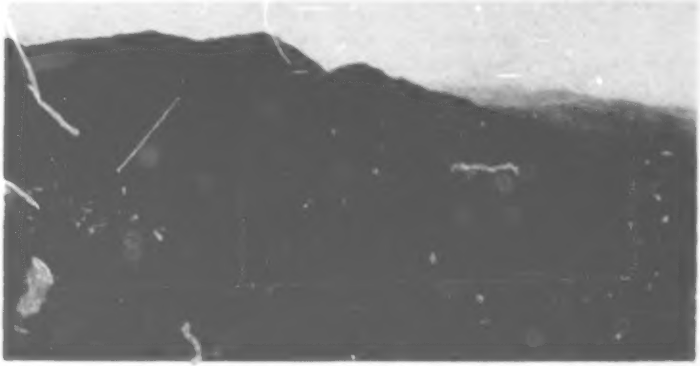
The typical wilderness in 1964 was large; the smallest was the 5,400-acre Great Gulf Wilderness in New Hampshire. Today's Wilderness System includes several small areas, the smallest being the 6-acre Pelican Island Wilderness in Florida. Also included in the system now are areas that have felt the impact of man's activities in modern times but have subsequently been restored by nature to wilderness condition.

Altogether, Wilderness Areas in 1975 amounted to 12.7 million acres, [107] which is 2 percent of our public lands and 0.5 percent of all the land in the United States.

The process of augmenting the Wilderness System is by no means ended. Besides making the mandatory reviews which the Wilderness Act required, the Forest Service has gone on to review 56 million more acres of roadless, undeveloped land in the National Forests and has selected some 274 new study areas containing 12.3 million acres for possible addition to the Wilderness System.[108]

The National Wild and Scenic Rivers System

Another component of our natural heritage is the Wild and Scenic Rivers System, established by law in 1968.[109] The Wild and Scenic



The Great Gulf Wilderness, New Hampshire, was one of the 4 original Wilderness Areas in the eastern half of the country; 16 more were added in 1974.

Rivers Act designated all or parts of 8 rivers for the system, named 27 others for study as possible additions, and established procedures for adding to the system. The purpose of the law is to save some of our remaining free-flowing rivers from dams and other water developments that would tame or transform them and to restrict riverbank development that would spoil their surroundings.

Rivers chosen for the system must have water of high quality and possess outstanding scenic, recreational, geologic, fish and wildlife, historic, or cultural values. Three categories of river are included: wild, scenic, and recreational. Wild stretches of rivers are the most primitive, difficult of access, and unchanged. Scenic stretches are free of impoundments, largely primitive, and undeveloped, but they may be accessible by road and may have some recreational facilities. Recreational segments are readily accessible by road or railroad. Although they may have some development along the banks and may have undergone some impoundment or diversion in the past, they are aesthetically pleasing and provide special opportunities for recreation.

There are now 12 Wild and Scenic Rivers (10 are wholly or partially federally administered).[110] The newest is the Chattooga River, which begins in the Blue Ridge Mountains of North Carolina, forms the border of South Carolina and Georgia, and empties into Lake Tugaloo.

In order to limit the time of uncertainty for riverside property owners, the Congress set a deadline of October 2, 1978, for studying the rivers initially identified in the act. At the same time, those under mandatory review are protected against dams or other water resource development until the study period is ended.[111]

EVENTS OF THE PAST YEAR

Wilderness Preservation

Nineteen seventy-four was a landmark year for wilderness preservation. It was the golden anniversary of the first wilderness area, the Gila. The 10-year federal review of areas suitable for wilderness under the Wilderness Act was concluded. The Congress passed the Eastern Wilderness Areas Act, which added 16 areas from eastern National Forests to the Wilderness System.[112] Comprising some 207,000 acres, the 16 were not originally selected for review in the Wilderness Act because they had been altered by man's activities. But nature has restored them to near pristine condition, and under the new act, these National Forest areas may be given the same protection as virgin wilderness. The act also calls for review of 17 additional eastern areas, totaling approximately 125,000 acres.

As of December 31, 1974, there were Administration proposals to add 26.9 million acres to the 12.3 million acres already in the Wilderness System (see Table 23). Inevitably, there is disagreement over

Table 23

Existing and Proposed Wilderness Areas, December 1974

(In millions of acres)

Designated wilderness in the 1964 act	9.1
Additions since 1964	
From National Forests	2.8
From National Parks	0.2
From Wildlife Refuges	0.6
Total	12.7
Proposed additions by the Administration	
From National Forests	3.6
From National Parks	15.8
From Wildlife Refuges	7.5
Total	26.9
Total enacted and proposed	39.6

Source: Forest Service, National Park Service and Fish and Wildlife Service.

the proposals. Conservation groups have chosen another 8.2 million acres from areas reviewed so far which they believe merit protection as wilderness.[113] If the Congress adopts all the Administration's proposals, there will be nearly 40 million acres of wilderness permanently protected. Besides that, there is 35.5 million acres more which is slated for review (see Table 24).

The largest review area is in Alaska, where 19.2 million acres of National Park and Wildlife Refuge is a candidate for wilderness designation. Although under the 1964 Wilderness Act this area should have been studied, the Interior Department postponed review because of possible conflict with a special law governing disposition of federal lands in Alaska, the Alaskan Native Claims Settlement Act.[114]

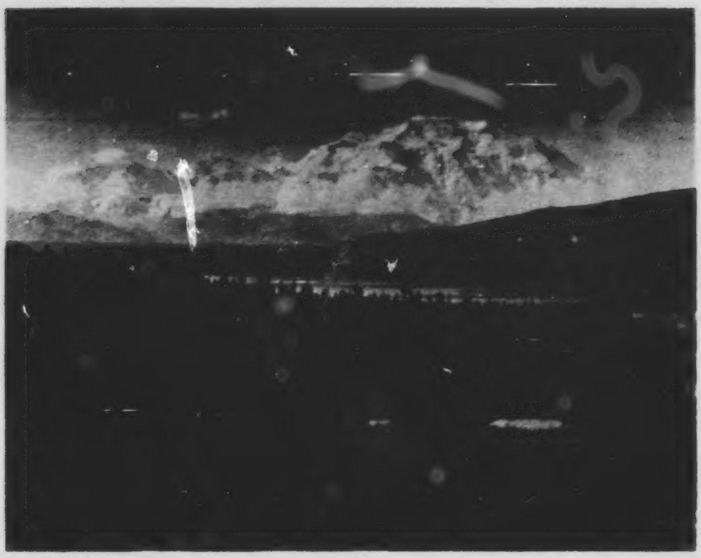
Another important category of land for which reviews are to be completed is the 12.3 million acres of new study areas, selected from over 56 million roadless acres of National Forests. The Forest Service made these selections not only for basic wilderness value but also with an eye to adding diverse, geographically representative areas to the Wilderness System.[115]

Table 24

Areas To Be Reviewed for Addition to the Wilderness Preservation System, December 1974

Alaska Park and Wildlife Refuge units (postponed)	19,204,700
Other National Park and Wildlife Refuge areas mandated for review	3,200,000
Eastern wilderness reviews (Forest Service)	125,000
Other Forest Service wilderness study areas mandated for review by special Acts of Congress	673,000
National Forest "new study areas"	12,300,000
Total	35,502,700

Source: Forest Service, National Park Service, and Fish and Wildlife Service.



Mt. McKinley National Park exemplifies the wilderness values to be found in Alaska's public lands.

Wild and Scenic Rivers

Hells Canyon, the deepest canyon in North America, has been threatened with a dam for over 20 years. The Pacific Northwest Power Company first proposed a dam on the Hells Canyon section of the Middle Snake River, which forms the border of Idaho, Washington, and Oregon, in November 1954.[116] The proposal has been urged repeatedly since then—and just as vigorously opposed.

On this issue 1975 may well be the year of decision. The Federal Power Commission imposed a 4-year moratorium on dam construction for the Middle Snake in 1971 to allow time for the Congress to consider whether to include part of the river in the Wild and Scenic Rivers System.

It is a classic case of energy needs versus environmental values. The proposed dam would inundate 55–99 miles of riverbank and would partially flood Hells Canyon. The canyon is not only unparalleled scenically; it is also habitat for many kinds of wildlife. The dam would change all that through destruction or serious impairment. It would eliminate much of the giant sturgeon population of the Middle Snake, one of the few streams where the largest of America's freshwater fishes still reproduces successfully. And it would cause a marked decline in the smallmouth bass population within the inundated segment, which now contributes to the reputation of the Snake River as the most famous smallmouth bass stream in the West. It would also adversely affect the river's salmon and steelhead runs, which make a large contribution to the Pacific fisheries from California to Alaska.[117] On the other hand, the dam would offer 2,600–4,000 megawatts of electricity, depending on the alternative chosen.[118]

The Administration has opted to protect Hells Canyon, urging inclusion of a 68-mile segment of the Middle Snake in the Wild and Scenic Rivers System. The current session of Congress has the issue under consideration. In June 1975 the Senate passed a plan that would create a Hells Canyon National Recreation Area of 700,000 acres, 200,000 of it in the National Wilderness System, and that would maintain the free flow of the river for 101 miles, from the existing Hells Canyon dam on the Middle Snake to a point near Lewiston, Idaho.[119]

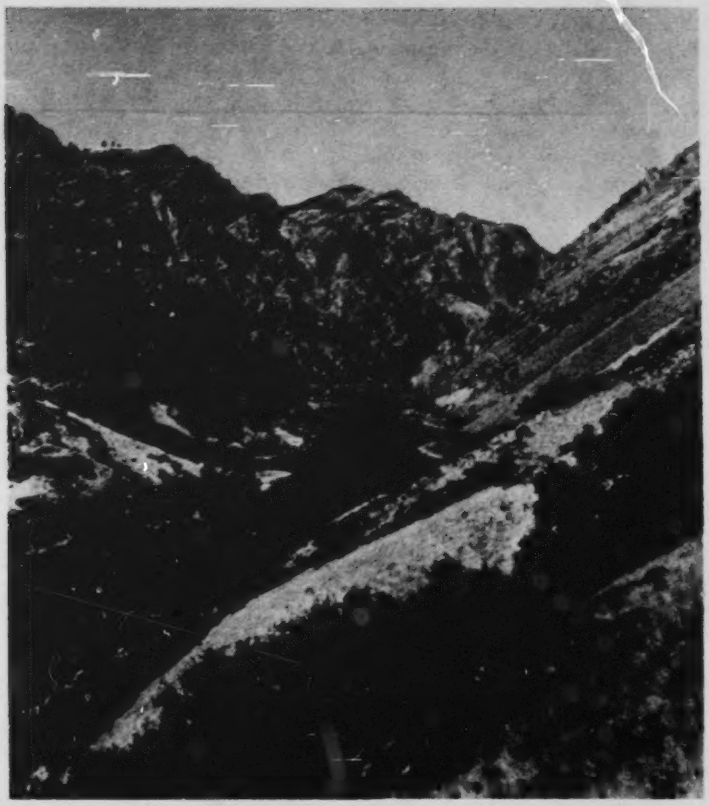
On January 3, 1975, the Wild and Scenic Rivers Act was amended by directing the study of 29 additional rivers for inclusion in the system. Reports on 28 of them must be ready October 2, 1979; the Dolores River, Colorado, study is to be completed by January 3, 1976.[120]

ISSUES TO WATCH FOR

The Hells Canyon controversy is but one example of pressure for development in our remaining wild heritage. Many splendid areas are now protected by the Wilderness Act and the Wild and Scenic Rivers Act, but the potential dwarfs what has been done so far. In 1961, more wild lands were protected through Forest Service designation—14.6 million acres—than are formally protected today under the two wilderness acts—12.7 million acres.

The proposal by the Administration to add 26.9 million acres to the wilderness preserve would be substantial. Yet an enormous potential has not been considered. To date, there have been no wilderness areas set aside from the 100 million acres of roadless, undeveloped public lands administered by the Bureau of Land Management.[121] The Wilderness Act required no review of this vast acreage. It has been proposed that review requirements be made a part of the pending BLM Organic Act.[122] Meanwhile, BLM has administratively designated 171,000 acres out of the 100 million as primitive areas.[123]

In spite of intense interest and activity by the public and the public lands agencies over the past 10 years, the major decisions on how much permanent wilderness we need still lie before us. At a generous estimate, over 200 million acres of land is still suitable for wilderness designation. It is important to make the decisions expeditiously. Resolving the uncertainty surrounding use of the potential wilderness areas is essential, not only to preservation of our national heritage but to sound, long-range resource management as well. Even more basic, we need to ask how much wilderness the nation should have.



North America's deepest canyon, Hell's Canyon, will be flooded if dams are built on the Middle Snake River, Idaho.

Too little may result in its overuse by visitors; too much could mean unnecessary exclusion of other uses which the land could support.

An area in special need of attention is Alaska. The disposition of federal lands in the former territory is far from settled. The Administration has recommended to the Congress approximately 84 million acres for inclusion in National Park, Forest, Wildlife Refuge, and Wild and Scenic Rivers Systems. The Secretary of the Interior proposes to give 32 million acres each to National Parks and Wildlife Refuges, 19 million to National Forests, and 1 million to the Wild and Scenic Rivers System.[124]

No one is entirely satisfied with the proposed division. The struggle over apportionment reflects something more than bureaucratic empire building. Environmentalists generally favor putting the land in systems whose chief aim is preservation—the National Park and Wild and Scenic Rivers Systems. Others favor more land in the National Forests because some resource use is permitted. If the Congress does not act by 1978, the 84 million acres will revert to their previous status as unreserved public domain.[125]

WILDLIFE

BACKGROUND

Our wildlife is a rich and varied national resource. It encompasses 800 species of birds, 400 species of mammals, 460 species of reptiles and amphibians, 660 species of freshwater fishes, and thousands of invertebrate species. Yet most of the ecosystems that were here before the Europeans settled have either disappeared or have been reduced to relics. Many species of wildlife have suffered a similar fate. The early records are so incomplete that our wildlife losses will never be fully known. The Fish and Wildlife Service list of species that are extinct or presumed extinct includes 32 birds, 9 mammals, and 6 fishes.[126] We have also lost many local populations of wildlife—the grizzly bears from the central Rocky Mountains, peregrine falcons from east of the Mississippi, and bighorn sheep from much of the western United States.

The science of wildlife management has significantly improved the status of some wildlife in the United States. Initially, emphasis was on the hunted and fished species in order to produce a surplus of fish and game for sport harvest. Subsequently, some attention has been paid to endangered and nongame species, although neither has been a major focus of effort.

In addition to the direct effects of wildlife management, wildlife has benefited too from general improvement in the quality of the human environment. Pollution control combined with restocking is returning some polluted waters to their more natural conditions. In June 1975, an Atlantic salmon was caught in the Connecticut River, the first since the species was driven out more than a century ago by industrialization, pollution, and overfishing. An 8-year effort to clean up and restock the river is succeeding.[127]

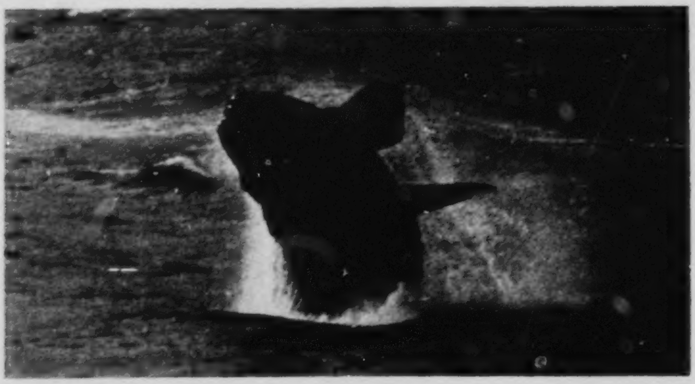
Under U.S. law, native wildlife belongs to the people; it is not private property, even on private land. Responsibility for management is shared by the federal and state governments. Resident wildlife which does not migrate between states or nations is under the jurisdiction of state governments. In addition to its responsibility for the wildlife administered by various federal agencies on public lands, the federal government is responsible for migratory waterfowl and a variety of birds and mammals covered by international treaties.[128]

Primary responsibility under the Marine Mammal Protection Act of 1972[129] and the Endangered Species Act of 1973[130] rests with the federal government. However, cooperation with the states is an essential part of the acts, and the states are given the option of taking a leading role in implementing many major provisions. The federal responsibility for management is primarily that of the Fish and Wildlife Service of the Department of the Interior and the National Marine Fisheries Service of the National Oceanic and Atmospheric Agency in the Department of Commerce.

A system of national wildlife sanctuaries was born in 1903 when President Theodore Roosevelt designated Pelican Island, Florida, a federal refuge. Over the years the system has grown under the jurisdiction of the U.S. Fish and Wildlife Service, which has responsibility for most of the preserves.

As of June 30, 1974, there were 367 National Wildlife Refuges encompassing over 32 million acres in 49 states. Every state except West Virginia has at least one unit in the system. The primary purpose of the National Wildlife Refuges is to protect and provide breeding grounds for wildlife, particularly migratory birds and endangered species. The refuges were established to preserve wildlife habitat, and no fewer than 136 refuges protect 1 or more of 39 endangered species.[131]

In addition to all lands categorized as Migratory Waterfowl Refuges (276), General Migratory Bird Refuges (68), Big Game Areas (16), National Game Ranges (4), and National Wildlife Ranges (4), the system includes 1.4 million acres of wetlands in Montana, Minnesota, Nebraska, and North and South Dakota, administratively classified as 116 Waterfowl Production Areas. Parcels of public domain and other federally owned lands originally acquired by the Army Corps of Engineers or the Bureau of Reclamation are now managed by the Fish and Wildlife Service for wildlife and related uses through long-term leases to the states. There are 59 of these "Coordination Areas" containing 436,000 acres.[132]



The right whale is one of five species of large whales that has been endangered by commercial harvesting and is not protected.

The National Wildlife Refuge System Administration Act of 1966 is the organic act consolidating federal wildlife holdings into a national system administered by the U.S. Fish and Wildlife Service.[183] The intent of the act is to pull together the existing laws—to provide statutory authority "for the conservation, protection, and propagation of native species of fish and wildlife, including migratory birds, that are threatened with extinction" and to consolidate the authority for administration of the National Wildlife Refuge System by the Secretary of the Interior.

The law thus gives the Interior Department broad discretion on what sort of activities will be allowed in refuges. In this way, breeding grounds and other sensitive areas may be protected as wildlife sanctuaries. Some areas are closed to the public at various times, such as breeding seasons, or as in the case of the Aransas National Wildlife Refuge on the Texas Gulf Coast, when the endangered whooping cranes are using it as a wintering grounds. At the same time, as mentioned in the section on outdoor recreation, almost all of the refuges are open to limited hunting.

Management of each refuge must be tailored to the species and habitat being protected. The Arctic National Wildlife Refuge, an 8.9-million acre sanctuary for caribou, polar bears, grizzly bears, gray wolves, Dall's sheep, arctic foxes, waterfowl, and shore birds in northern Alaska, obviously needs a different management program than that of the 4,359-acre Pelican Island Refuge in Florida, where brown pelicans, white ibises, herons, egrets, and alligators are protected. The underlying thread is the protection of endangered species and threatened habitats.

In addition to establishing the National Wildlife Refuge System in 1966, the act granted the Secretary of the Interior broad powers

Grizzly bears, such as this mother with her cubs, are threatened with extinction in the lower United States.

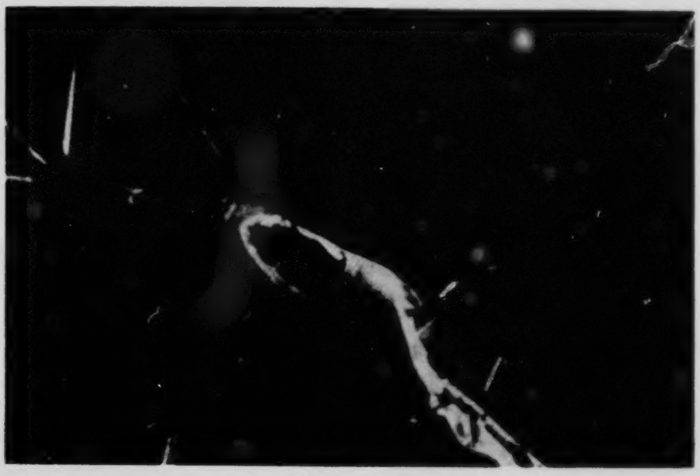
to acquire further lands for the system. The Secretary may do so under the amended Migratory Bird Conservation Act,[134] the Fish and Wildlife Act of 1956,[135] and the Fish and Wildlife Coordination Act.[136] Other Wildlife Refuges may be designated and reserved out of the public domain, acquired from federal agencies or from donations, or purchased or leased. A few have been created by the Congress.

EVENTS OF THE PAST YEAR

Endangered Species

The Endangered Species Act of 1973[137] made some important changes in the Endangered Species Acts of 1966 and 1969.[138] One extended protection to plants as well as animals. The Smithsonian Institution's list of endangered, threatened, recently extinct, and exploited species, subspecies, and varieties of native plants comprises about 10 percent of the flora of the continental United States, with 100 of these species, subspecies, and varieties recently (or possibly) extinct, 761 endangered, and 1,238 threatened. On a separate list, over 50 percent of Hawaii's flora is in these three categories—250 species, subspecies, and varieties extinct, 639 endangered, and 194 threatened.[139]

A significant provision of the Endangered Species Act requires federal agencies to ensure that their programs do not jeopardize endangered species or destroy or modify habitat critical to their



Cactus can provide food, water, and shelter for many species; this one has been partially eaten by wildlife. Cactus will be regulated under the Endangered Species Convention.

existence.[140] On May 16, 1975, the Fish and Wildlife Service gave notice that it intends to determine the "critical habitat" for 108 endangered species of the United States and Puerto Rico,[141] and in June critical habitat was proposed for the Mississippi sandhill crane.[142]

The 1973 act also implements the Convention on International Trade in Endangered Species of Wild Fauna and Flora, negotiated in March 1973 and effective July 1, 1975.[143] The convention establishes a system for monitoring and regulating international commerce in listed species of plants and animals, with the extent of regulation a function of the degree of threat.

Predator Control

The issue of predator control was presented in detail in last year's Annual Report. In 1972, the use of poisons on public lands was banned by Executive Order 11643 for all but predator control emergencies. Segments of the sheep industry insist that this action brought an increase in the number of coyotes and in coyote predation, which is driving them out of business. Others insist that economic factors are hurting the sheep industry far more than coyotes and that the industry has been in a virtually steady decline since the 1940's.

On July 18, 1975, President Ford amended the Executive order to permit expanded research to develop more effective and environmentally sound methods to protect livestock from coyote predation.[144] The amended order permits the experimental use of sodium cyanide on public lands for 1 year only. Sodium cyanide does not persist in the bodies of the animals that it poisons. Some other poisons that had been widely used before the ban, such as strychnine and 1080, do persist and may poison other animals that feed on the target animal after it is dead.

Sodium cyanide is now being field tested in such devices as the M–44 and the toxic collar. A spring-loaded device placed in the ground, the M–44 propels sodium cyanide powder into a coyote's mouth when it tugs on a triggering mechanism. The toxic collar is placed around a sheep's neck and releases a lethal dose of sodium cyanide when a coyote bites the collar. Although its effectiveness has yet to be proven, experimentation with the toxic collar is particularly important because it is the most selective device available, poisoning only coyotes that actually attack sheep.

In addition to these experimental efforts, the Administration has plans to strengthen the conventional coyote control program.

Management Authority for Refuges

In a district court suit, *Wilderness Society* v. *Hathaway*,[145] management of the Wildlife Refuge System was challenged. The case involves transfer of National Wildlife Refuge lands.[146] The Charles Sheldon Antelope Range in Nevada and Oregon, the Charles M.

Russell National Wildlife Refuge in Montana, and the Kofa Game Range in Arizona—which total 2.2 million acres—had been administered jointly by the Bureau of Land Management for grazing and mining and the Fish and Wildlife Service for all other purposes, particularly wildlife preservation. Early in 1975, the Secretary of the Interior transferred sole jurisdiction over the three ranges to BLM.[147]

The Wilderness Society suit charged that Interior lacked legal authority to effect the transfer and that no prior environmental impact statement or assessment had been made, violating the National Environmental Policy Act.[148] On grounds that a prior environmental impact statement was required, the District Court granted a preliminary injunction against the transfer of administrative duties, personnel, and management responsibility from the Fish and Wildlife Service to the Bureau of Land Management.

Despite BLM's promise that it would manage the areas as had the FWS, the Wilderness Society and other conservationists feared that administration of these game ranges by the Bureau of Land Management, an agency with a multiple use and resource development mission, would weaken the wildlife and preservation values that are the heart of the National Wildlife Refuge System.[149] They favor continued joint management or Fish and Wildlife Service control. Conservationists are also concerned about the uncertain status of nearly one-half the total acreage of these three game ranges as proposed Wilderness Areas. The Administration has deferred action on the wilderness question pending completion of mineral surveys "because the areas are open to mining and may contain minerals vital to the national interest." [150]

ISSUES TO WATCH FOR

Wildlife management has developed largely in response to the interests of hunters and fishermen. Although public concern with wildlife that is neither hunted nor fished has grown, the narrow focus on game persists. In fiscal year 1975, 3.5 percent of all wildlife management funds and 25 percent of the research funds of 13 federal agencies were directed to nongame wildlife. The figure is even lower in the state agencies where funds may derive solely from licenses and taxes on sporting goods paid by hunters and fishermen. In fiscal year 1975, for example, nongame wildlife received 1 percent of state management funding, 4 percent of state research funding, and 2 percent of state wildlife law enforcement funding.[151]

Recent legislation, such as the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972, has significantly improved the potential for better management of nongame wildlife. In addition, the Sikes Act Extension for Wildlife provides for federal-state cooperation to conserve and rehabilitate wildlife, fish, and certain game on public lands.[152] The agencies involved are required to develop comprehensive plans to achieve these objectives. The plans emphasize the importance of habitat, moving from the single species

A bull elk with horns in summer velvet grazes undisturbed in Yellowstone National Park.

approach to habitat or ecosystem management. Further, the well-established Pittman-Robertson Wildlife Restoration Act [153] authorizes federal support of comprehensive programs of wildlife management, even though it has long been used primarily to support the management of game species.

Nevertheless, most wildlife management efforts remain directed at game species. Full implementation of existing legislation would provide better management of wildlife. But some legislative change may be necessary before wise management and conservation of all wildlife are achieved.

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135. 16 U.S.C. § 742(a)–(j), 70 Stat. 1119 (1970).

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141. 40 Fed. Reg. 96 (1975).
142. 40 Fed. Reg. 126 (1975).
143. 16 U.S.C. § 1537(e).
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146. Public Land Orders No. 5492, 40 Fed. Reg. 14054, No. 5497 and No. 5498, 40 Fed. Reg. 18996, 18997.
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APPENDIX

Table 25

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Agua Tibia	16,971	California	FS	Established 1/3/75 P.L. 93–632
Anaconda Pintlar	159,086	Montana	FS	Established 9/3/64 P.L. 88–577
Beaver Creek	5,500	Kentucky	FS	Established 1/3/75 P.L. 93–622
Bering Sea	41,113	Alaska	FWS	Established 10/23/70 P.L. 91–504
Black Beard Island	3,000	Georgia	FWS	Established 1/3/75 P.L. 93–632
Bob Marshall	950,000	Montana	FS	Established 9/3/64 P.L. 88–577
Bogoslof	390	Alaska	FWS	Established 10/23/70 P.L. 91–504
Bosque del Apache	30,850	New Mexico	FWS	Established 1/3/75 P.L. 93–632
Boundary Waters Canoe Area	1,034,852	Minnesota	FS	Established 9/3/64 P.L. 88–577
Bradwell Bay	22,000	Florida	FS	Established 1/3/75 P.L. 93–622
Breton	5,000	Louisiana	FWS	Established 1/3/75 P.L. 93–632
Bridger	392,160	Wyoming	FS	Established 9/3/64 P.L. 88–577
Brigantine	6,603	New Jersey	FWS	Established 1/3/75 P.L. 93–632
Bristol Cliffs	6,500	Vermont	FS	Established 1/3/75 P.L. 93–622
Cabinet Mountains	94,272	Montana, Idaho	FS	Established 9/3/64 P.L. 88–577
Caney Creek	14,433	Arkansas	FS	Established 1/3/75 P.L. 93–622
Cape Romain	28,000	South Carolina	FWS	Established 1/3/75 P.L. 93–632
Caribou	19,080	California	FS	Established 9/3/64 P.L. 88–577
Cedar Keys	375	Florida	FWS	Established 8/7/72 P.L. 92–364
Chamisso	455	Alaska	FWS	Established 1/3/75 P.L. 93–632
Chase Lake	4,155	North Dakota	FWS	Established 1/3/75 P.L. 93–632
Chiricahua	18,000	Arizona	FS	Established 9/3/64 P.L. 88–577
Cohutta	34,500	Georgia, Tennessee	FS	Established 1/3/75 P.L. 93–622
Craters of the Moon	43,243	Idaho	NPS	Established 10/23/70 P.L. 91–504
Cucamonga	9,022	California	FS	Established 9/3/64 P.L. 88–577

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Desolation	63,500	California	FS	Established 10/10/69 P.L. 91-82
Diamond Peak	35,440	Oregon	FS	Established 9/3/64 P.L. 88-577
Dolly Sods	10,215	West Virginia	FS	Established 1/3/75 P.L. 93-622
Dome Land	62,561	California	FS	Established 9/3/64 P.L. 88-577
Eagle Cap[3]	292,700	Oregon	FS	Established 9/3/64 P.L. 88-577
Ellicott Rock	3,600	Georgia, North Carolina, South Carolina	FS	Established 1/3/75 P.L. 93-622
Emigrant	106,910	California	FS	Established 1/3/75 P.L. 93-632
Farallon	141	California	FWS	Established 12/26/74 P.L. 93-550
Florida Keys	4,740	Florida	FWS	Established 1/3/75 P.L. 93-632
Forrester Island	2,630	Alaska	FWS	Established 10/23/70 P.L. 91-504
Galiuro	55,000	Arizona	FS	Established 9/3/64 P.L. 88-577
Gates of the Mountains	28,562	Montana	FS	Established 9/3/64 P.L. 88-577
Gearhart Mountain	18,709	Oregon	FS	Established 9/3/64 P.L. 88-577
Gee Creek	2,570	Tennessee	FS	Established 1/3/75 P.L. 93-622
Gila	438,626	New Mexico	FS	Established 9/3/64 P.L. 88-577
Glacier Peak[3]	468,505	Washington	FS	Established 9/3/64 P.L. 88-577
Goat Rocks	82,680	Washington	FS	Established 9/3/64 P.L. 88-577
Great Gulf	5,400	New Hampshire	FS	Established 9/3/64 P.L. 88-577
Great Swamp	3,660	New Jersey	FWS	Established 9/28/68 P.L. 90-532
Hazy Islands	42	Alaska	FWS	Established 10/23/70 P.L. 91-504
Hoover	47,900	California	FS	Established 9/3/64 P.L. 88-577
Huron Islands	105	Michigan	FWS	Established 10/23/70 P.L. 91-504
Island Bay	20	Florida	FWS	Established 10/23/70 P.L. 91-504
James River Face	8,800	Virginia	FS	Established 1/3/75 P.L. 93-622
Jarbidge	64,827	Nevada	FS	Established 9/3/64 P.L. 88-577
John Muir	504,263	California	FS	Established 9/3/64 P.L. 88-577

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Joyce Kilmer-Slickrock	15,000	Tennessee, North Carolina	FS	Established 1/3/75 P.L. 93–622
Kalmiopsis	78,850	Oregon	FS	Established 9/3/64 P.L. 88–577
La Garita	49,000	Colorado	FS	Established 9/3/64 P.L. 88–577
Lassen Volcanic	78,982	California	NPS	Established 10/19/72 P.L. 92–510
Lava Beds	28,460	California	NPS	Established 10/13/72 P.L. 92–493
Linville Gorge	7,655	North Carolina	FS	Established 9/3/64 P.L. 88–577
Lostwood	5,577	North Dakota	FWS	Established 1/3/75 P.L. 93–632
Lye Brook	14,300	Vermont	FS	Established 1/3/75 P.L. 93–622
Marble Mountain	214,543	California	FS	Established 9/3/64 P.L. 88–577
Maroon Bells-Snowmass	66,280	Colorado	FS	Established 9/3/64 P.L. 88–577
Mazatzal	205,346	Arizona	FS	Established 9/3/64 P.L. 88–577
Michigan Islands	12	Michigan	FWS	Established 10/23/70 P.L. 91–504
Minarets	109,559	California	FS	Established 9/3/64 P.L. 88–577
Mission Mountains	75,588	Montana	FS	Established 1/3/75 P.L. 93 –632
Mokelumne	50,400	California	FS	Established 9/3/64 P.L. 88–577
Monomoy	2,420	Massachusetts	FWS	Established 10/23/70 P.L. 91–504
Moosehorn[4]	7,304	Maine	FWS	Established 10/23/70 P.L. 91–504
Mount Adams	42,411	Washington	FS	Established 9/3/64 P.L. 88–577
Mount Baldy	7,000	Arizona	FS	Established 10/23/70 P.L. 91–504
Mount Hood	14,160	Oregon	FS	Established 9/3/64 P.L. 88–577
Mount Jefferson	100,000	Oregon	FS	Established 10/2/68 P.L. 90–548
Mount Washington	46,655	Oregon	FS	Established 9/3/64 P.L. 88–577
Mount Zirkel	72,180	Colorado	FS	Established 9/3/64 P.L. 88–577
Mountain Lakes	23,071	Oregon	FS	Established 9/3/64 P.L. 88–577
North Absaroka	351,104	Wyoming	FS	Established 9/3/64 P.L. 88–577

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Okefenokee	353,981	Georgia	FWS	Established 10/1/74 P.L. 93-429
Oregon Islands	21	Oregon	FWS	Established 10/23/70 P.L. 91-504
Otter Creek	20,000	West Virginia	FS	Established 1/3/75 P.L. 93-622
Pasayten	500,000	Washington	FS	Established 10/2/68 P.L. 90-544
Passage Key	36	Florida	FWS	Established 10/23/70 P.L. 91-504
Pecos	165,000	New Mexico	FS	Established 9/3/64 P.L. 88-577
Pelican Island	6	Florida	FWS	Established 10/23/70 P.L. 91-504
Petrified Forest	50,260	Arizona	NPS	Established 10/23/70 P.L. 91-504
Pine Mountain	20,061	Arizona	FS	Established 2/15/72 P.L. 92-230
Presidential Range-Dry River	20,380	New Hampshire	FS	Established 1/3/75 P.L. 93-622
Rainbow Lake	6,600	Wisconsin	FS	Established 10/23/70 P.L. 91-504
Rawah	26,797	Colorado	FS	Established 9/3/64 P.L. 88-577
Saint Lazaria	65	Alaska	FWS	Established 10/23/70 P.L. 91-504
Saint Marks	17,746	Florida	FWS	Established 1/3/75 P.L. 93-632
Salt Creek	9,621	New Mexico	FWS	Established 10/23/70 P.L. 91-504
San Gabriel	36,000	California	FS	Established 5/24/68 P.L. 90-318
San Gorgonio	34,718	California	FS	Established 9/3/64 P.L. 88-577
San Jacinto	21,955	California	FS	Established 9/3/64 P.L. 88-577
San Pedro Parks	41,132	New Mexico	FS	Established 9/3/64 P.L. 88-577
San Rafael	143,000	California	FS	Established 3/21/68 P.L. 90-271
Sawtooth	216,383	Idaho	FS	Established 8/22/72 P.L. 92-400
Scapegoat	240,000	Montana	FS	Established 8/20/72 P.L. 92-395

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Selway-Bitterroot	1,243,659	Idaho, Montana	FS	Established 9/3/64 P.L. 88-577
Seney	25,150	Michigan	FWS	Established 10/23/70 P.L. 91-504
Shining Rock	13,400	North Carolina	FS	Established 9/3/64 P.L. 88-577
Sierra Ancha	20,850	Arizona	FS	Established 9/3/64 P.L. 88-577
Sipsey	12,000	Alabama	FS	Established 1/3/75 P.L. 93-622
South Warner	69,547	California	FS	Established 9/3/64 P.L. 88-577
Strawberry Mountain	33,653	Oregon	FS	Established 9/3/64 P.L. 88-577
Superstition	124,140	Arizona	FS	Established 9/3/64 P.L. 88-577
Sycamore Canyon	48,500	Arizona	FS	Established 3/6/72 P.L. 92-241
Teton	563,500	Wyoming	FS	Established 9/3/64 P.L. 88-577
Thousand Lakes	16,335	California	FS	Established 9/3/64 P.L. 88-577
Three Arch Rocks	17	Oregon	FWS	Established 10/23/70 P.L. 91-504
Three Sisters	196,708	Oregon	FS	Established 9/3/64 P.L. 88-577
Tuxedni	6,402	Alaska	FWS	Established 10/23/70 P.L. 91-504
Upper Buffalo	10,590	Arkansas	FS	Established 1/3/75 P.L. 93-622
Ventana	98,000	California	FS	Established 8/18/69 P.L. 91-58
Washakie[4]	714,300	Wyoming	FS	Established 9/3/64 P.L. 88-577
Washington Islands	179	Washington	FWS	Established 10/23/70 P.L. 91-504
Weminuche	405,031	Colorado	FS	Established 1/3/75 P.L. 93-632
West Elk	61,412	Colorado	FS	Established 9/3/64 P.L. 88-577
West Sister Island	85	Ohio	FWS	Established 1/3/75 P.L. 93-632
Wheeler Park	6,051	New Mexico	FS	Established 9/3/64 P.L. 88-577
White Mountain	28,230	New Mexico	FS	Established 9/3/64 P.L. 88-577
Wichita Mountains	8,570	Oklahoma	FWS	Established 10/23/70 P.L. 91-504
Wisconsin Islands	29	Wisconsin	FWS	Established 9/3/64 P.L. 88-577
Wolf Island	5,126	Georgia	FWS	Established 1/3/75 P.L. 93-632

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Yolla Bolly-Middle Eel	111,091	California	FS	Established 9/3/64 P.L. 88-577
Agassiz	4,000	Minnesota	FWS	Proposed to Congress
Aldo Leopold	188,000	New Mexico	FS	Proposed to Congress
Aleutian Islands	1,395,357	Alaska	FWS	Proposed to Congress
Anaho Island	747	Nevada	FWS	Proposed to Congress
Arches	15,703	Utah	NPS	Proposed to Congress
Arctic	8,900,000	Alaska	FWS	Delayed by ANCSA[6]
Assateague Island National Seashore	440	Maryland	NPS	Proposed to Congress
Back Bay	2,165	Virginia	FWS	Proposed to Congress
Badlands	58,924	South Dakota	NPS	Proposed to Congress
Bandelier	22,030	New Mexico	NPS	Proposed to Congress
Beartooth	230,000	Montana	FS	Proposed to Congress
Big Bend	533,900	Texas	NPS	Proposed to Congress
Big Lake	1,818	Arkansas	FWS	Proposed to Congress
Black Canyon of the Gunnison	11,180	Colorado	NPS	Proposed to Congress
Blue Range	177,000	Arizona, New Mexico	FS	Proposed to Congress
Bombay Hook	2,000	Delaware	FWS	Proposed to Congress
Bryce Canyon	16,303	Utah	NPS	Proposed to Congress
Cabeza Prieta	833,500	Arizona	FWS	Proposed to Congress
Capitol Reef	23,054	Utah	NPS	Proposed to Congress
Carlsbad Caverns	30,210	New Mexico	NPS	Proposed to Congress
Cedar Breaks	4,370	Utah	NPS	Proposed to Congress
Cedar Island	180	North Carolina	FWS	Proposed to Congress
Charles M. Russell	155,288	Montana	FWS	Proposed to Congress
Charles Sheldon Antelope Range	321,400	Nevada	FWS	Proposed to Congress
Chassahowitzka	16,900	Florida	FWS	Proposed to Congress
Chincoteague Refuge	1,300	Virginia	FWS	Proposed to Congress
Chiricahua	9,440	Arizona	NPS	Proposed to Congress
Clarence Rhode	2,887,026	Alaska	FWS	Delayed by ANCSA

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Cloud Peak	137,000	Wyoming	FS	Proposed to Congress
Colorado	7,700	Colorado	NPS	Proposed to Congress
Crab Orchard	4,050	Illinois	FWS	Proposed to Congress
Crater Lake	122,400	Oregon	NPS	Proposed to Congress
Crescent Lake	24,502	Nebraska	FWS	Proposed to Congress
Cumberland Gap	6,375	Kentucky, Virginia, Tennessee	NPS	Proposed to Congress
Death Valley	1,908,000	California, Nevada	NPS	Proposed to Congress
Desert	1,443,300	Nevada	FWS	Proposed to Congress
Dinosaur	165,341	Colorado, Utah	NPS	Proposed to Congress
Eagles Nest	83,000	Colorado	FS	Proposed to Congress
Everglades	1,296,500	Florida	NPS	Proposed to Congress
Flat Tops	142,000	Colorado	FS	Proposed to Congress
Fort Niobrara	4,635	Nebraska	FWS	Proposed to Congress
Gila (addition)	130,000	New Mexico	FS	Proposed to Congress
Glacier	927,550	Montana	NPS	Proposed to Congress
Glacier	183,000	Wyoming	FS	Proposed to Congress
Glacier Bay	2,210,600	Alaska	NPS	Deferred pending mineral survey
Grand Canyon	512,870	Arizona	NPS	Proposed to Congress
Grand Teton	115,807	Wyoming	NPS	Proposed to Congress
Great Sand Dunes	32,930	Colorado	NPS	Proposed to Congress
Great Smoky Mountains	390,500	Tennessee, North Carolina	NPS	Proposed to Congress
Guadalupe Mountains	46,850	Texas	NPS	Proposed to Congress
Haleakala	19,270	Hawaii	NPS	Proposed to Congress
Hart Mountain	16,500	Oregon	FWS	Proposed to Congress
Havasu	2,510	Arizona, California	FWS	Proposed to Congress
Hawaii Volcanoes	123,100	Hawaii	NPS	Proposed to Congress
Hawaiian Islands	1,742	Hawaii	FWS	Proposed to Congress
Hazen Bay	6,800	Alaska	FWS	Delayed by ANCSA
High Unitas	323,000	Utah	FS	Proposed to Congress

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Idaho	1,225,000	Idaho	FS	Proposed to Congress
Imperial	12,010	Arizona, California	FWS	Proposed to Congress
Isle Royale	129,573	Michigan	NPS	Proposed to Congress
Izembek	301,451	Alaska	FWS	Delayed by ANCSA
J.N. "Ding" Darling	2,735	Florida	FWS	Proposed to Congress
Joshua Tree	372,700	California	NPS	Proposed to Congress
Katmai	2,603,547	Alaska	NPS	Proposed to Congress
Kenai	829,000	Alaska	FWS	Proposed to Congress
Kings Canyon-Sequoia	750,690	California	NPS	Proposed to Congress
Kodiak	1,815,000	Alaska	FWS	Delayed by ANCSA
Kofa	570,600	Arizona	FWS	Proposed to Congress
Lacassaire	2,854	Louisiana	FWS	Proposed to Congress
Lake Mead	469,300	Arizona, Nevada	NPS	Deferred pending study by Bureau of Reclamation
Lake Woodruff	1,106	Florida	FWS	Proposed to Congress
Malheur	30,000	Oregon	FWS	Proposed to Congress
Mattamuskeet	590	North Carolina	FWS	Proposed to Congress
Medicine Lake	11,366	Montana	FWS	Proposed to Congress
Mesa Verde	8,100	Colorado	NPS	Proposed to Congress
Mille Lacs	0.6	Minnesota	FWS	Proposed to Congress
Mingo	1,705	Missouri	FWS	Proposed to Congress
Missisquoi	620	Vermont	FWS	Proposed to Congress
Monarch	30,689	California	FS	Proposed to Congress
Mount McKinley	1,939,500	Alaska	NPS	Delayed by ANCSA
Mount Rainier	210,700	Washington	NPS	Proposed to Congress
North Cascades Complex	515,880	Washington	NPS	Proposed to Congress
Noxubee	1,200	Mississippi	FWS	Proposed to Congress
Nunivak	3,656,400	Alaska	FWS	Delayed by ANCSA
Olympic	862,139	Washington	NPS	Proposed to Congress
Organ Pipe Cactus	299,600	Arizona	NPS	Proposed to Congress
Parker River	3,110	Massachusetts	FWS	Proposed to Congress

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Pea Island	180	North Carolina	FWS	Proposed to Congress
Pinnacles	10,980	California	NPS	Proposed to Congress
Point Reyes	10,600	California	NPS	Proposed to Congress
Popo Agie	71,000	Wyoming	FS	Proposed to Congress
Red Rock Lakes	32,350	Montana	FWS	Proposed to Congress
Rice Lake	1,406	Minnesota	FWS	Proposed to Congress
Rocky Mountain	239,835	Colorado	NPS	Proposed to Congress
Saguaro	42,400	Arizona	NPS	Proposed to Congress
Salmon River Breaks	217,000	Idaho	FS	Proposed to Congress
San Juan Seashore	168	Washington	FWS	Proposed to Congress
Santee	163	South Carolina	FWS	Proposed to Congress
Semidi	256,000	Alaska	FWS	Proposed to Congress
Sheldon National Antelope Range	20,100	Nevada	FWS	Proposed to Congress
Shenandoah	79,689	Virginia	NPS	Proposed to Congress
Simenof	25,[illegible]	Alaska	FWS	Proposed to Congress
Spanish Peaks	63,000	Montana	FS	Proposed to Congress
Swanquarter	9,000	North Carolina	FWS	Proposed to Congress
Tamarac	2,138	Minnesota	FWS	Proposed to Congress
Theodore Roosevelt	28,335	North Dakota	NPS	Proposed to Congress
Trinity Alps	267,561	California	FS	Proposed to Congress
U.L. Bend	19,683	Montana	FWS	Proposed to Congress
Uncompahgre	53,000	Colorado	FS	Proposed to Congress
Unimak	973,000	Alaska	FWS	Proposed to Congress
Upper Mississippi	195,122	Illinois, Iowa, Minnesota, Wisconsin	FWS	Proposed to Congress
Valentine	16,317	Nebraska	FWS	Proposed to Congress
White River	975	Arkansas	FWS	Proposed to Congress
Wilson Mountains	30,000	Colorado	FS	Proposed to Congress
Yellowstone	2,016,181	Wyoming, Idaho, Montana	NPS	Proposed to Congress

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Yosemite	646,700	California	NPS	Proposed to Congress
Zion	120,620	Utah	NPS	Proposed to Congress
Big Cypress	—	Florida	NPS	Under study 10/11/74 P.L. 93-440
Big Frog	4,500	Tennessee	FS	Under study 1/3/75 P.L. 93-622
Big Thicket	—	Texas	NPS	Under study 10/11/74 P.L. 93-439
Belle Starr Cave	5,700	Arkansas	FS	Under study 1/3/75 P.L. 93-622
Buffalo River	—	Arkansas	NPS	Under study 3/1/75 P.L. 92-237
Canaveral	—	Florida	NPS	Under study 1/3/75 P.L. 93-626
Canyonlands	—	Utah	NPS	Under study 11/12/71 P.L. 92-154
Cape Lookout	—	North Carolina	NPS	Under study 10/26/74 P.L. 93-477
Citico Creek	14,000	Tennessee	FS	Under study 1/3/75 P.L. 93-622
Craggy Mountain	1,100	North Carolina	FS	Under study 1/3/75 P.L. 93-622
Cranberry	36,300	West Virginia	FS	Under study 1/3/75 P.L. 93-622
Cumberland Island	—	Georgia	NPS	Under study 10/23/72 P.L. 92-536
Dry Creek	5,500	Arkansas	FS	Under study 1/3/75 P.L. 93-622
Du Noir Basin	—	Wyoming	FS	Under study 10/9/72 P.L. 92-476
Flynn Lake	6,300	Wisconsin	FS	Under study 1/3/75 P.L. 93-622
Glen Canyon	—	Arizona, Utah	NPS	Deferred until 10/27/75 P.L. 92-593
Gulf Islands	—	Florida, Mississippi	NPS	Under study 10/21/70 P.L. 91-660
Hoover-Cherry Creek Addition	6,042	California	FS	Under study 1/3/75 P.L. 93-632
Indian Peaks	71,000	Colorado	FS	Under study 10/21/72 P.L. 92-528

See footnotes at end of table.

Table 25—Continued

Wilderness Preservation System, June 1, 1975[1]

Wilderness	Acres	Location	Sponsor	Status/Public Law
Lower Minam	32,000	Oregon	FS	Under study 10/21/72 P.L. 92-521
Mill Creek	4,000	Virginia	FS	Under study 1/3/75 P.L. 93-622
Mountain Lake	8,400	Virginia	FS	Under study 1/3/75 P.L. 93-622
Oregon Dunes	—	Colorado	FS	Under study 3/24/72 P.L. 92-260
Peters Mountain	5,000	Virginia	FS	Under study 1/3/75 P.L. 93-622
Ramsey's Draft	6,700	Virginia	FS	Under study 1/3/75 P.L. 93-622
Rand Lake	4,200	Wisconsin	FS	Under study 1/3/75 P.L. 93-622
Richland Creek	2,100	Arkansas	FS	Under study 1/3/75 P.L. 93-622
Rock River Canyon	5,400	Michigan	FS	Under study 1/3/75 P.L. 93-622
Sleeping Bear Dunes	—	Michigan	NPS	Under study 10/21/70 P.L. 91-479
Sochoppy River	1,100	Florida	FS	Under study 1/3/75 P.L. 93-622
Sturgeon River	13,200	Michigan	FS	Under study 1/3/75 P.L. 93-622
Voyageurs	—	Minnesota	NPS	Under study 1/8/71 P.L. 91-661
Wambaw Swamp	1,500	South Carolina	FS	Under study 1/3/75 P.L. 93-622

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[1] FS–Forest Service; FWS–U.S. Fish and Wildlife Service; NPS–National Park Service. Dashes indicate that boundaries have not yet been determined.

[2] An addition was made to the Eagle Cap Wilderness by Public Law 92-521 in 1972.

[3] An addition was made to the Glacier Peak Wilderness by Public Law 90-544 on October 2, 1968.

[4] The Baring Unit was added to the existing Moosehorn Wilderness by Public Law 93-632 on January 3, 1975.

[5] The South Absaroka Wilderness Area was incorporated into the system on September 3, 1964. In 1972, the Stratified Rrimitive Area was added to it and the name was changed to Washakie by Public Law 92-476.

[6] Alaska Native Claims Settlement Act.

Table 26

Wild and Scenic Rivers System, June 1, 1975

River	Location	Segments	Sponsor	Status/Public Law
Allagash Wilderness Waterway	Maine	1	Interior	Established 7/19/70 by Secretary of the Interior
Chattooga	North Carolina, South Carolina, Georgia	2	Agriculture	Established 5/10/74 P.L. 98–278
Clearwater	Idaho	3	Agriculture	Established 10/2/68 P.L. 90–542
Eleven Point	Missouri	1	Agriculture	Established 10/2/68 P.L. 90–542
Feather	California	1	Agriculture	Established 10/2/68 P.L. 90–542
Little Miami River	Ohio	1	Interior	Established 8/20/73 by Secretary of the Interior
Lower St. Croix	Minnesota, Wisconsin	1	Interior	Established 10/25/72 P.L. 92–560
Rio Grande	New Mexico	1	Interior	Established 10/2/68 P.L. 90–542
Rogue	Oregon	1	Agriculture/Interior	Established 10/2/68 P.L. 90–542
Salmon	Idaho	1	Agriculture	Established 10/2/68 P.L. 90–542
St. Croix	Minnesota, Wisconsin	1	Interior	Established 10/2/68 P.L. 90–542
Wolf	Wisconsin	1	Interior	Established 10/2/68 P.L. 90–542
Alagnak	Southern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Alatna	Northern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
American	California	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93–621
Andreafsky	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73

See footnotes at end of table.

Table 26—Continued

Wild and Scenic Rivers System, June 1, 1975

River	Location	Segments	Sponsor	Status/Public Law
Aniakchack	Southern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Au Sable	Michigan	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Beaver [1]	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Big Thompson	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Birch [1]	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Bremer	Southern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Bruneau	Idaho	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Buffalo	Tennessee	1	Interior	Proposed for study 10/2/68 P.L. 90-542
Cache la Poudre	Colorado	1	Interior	Proposed for study 1/3/75 P.L. 93-621
Cahaba	Alabama	1	Interior	Proposed for study 1/3/75 P.L. 93-621
Charlie	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Clark's Fork	Wyoming	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Colorado	Colorado, Utah	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Conejos	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Delaware	Pennsylvania, New York	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Dolores	Colorado	4	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Elk	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Encampment	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Flathead	Montana	3	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542

Fortymile[1]	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Gasconade	Missouri	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Green	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Gunnison	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Illinois	Oklahoma	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Illinois	Oregon	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Ivishak	Northern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
John Day	Oregon	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Kanetok	Southern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Kettle	Minnesota	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Killik	Northern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Little Beaver[3]	Ohio	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Los Pinos	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Manistee	Michigan	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Missouri	Montana	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Moyie	Idaho	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Noatak	Northern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Nolichuckey	Tennessee, North Carolina	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Nowitna	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Obed	Tennessee	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Owyee	Oregon	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Penobscot	Maine	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Pere Marquette	Michigan	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Piedra	Colorado	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93-621
Pine Creek	Pennsylvania	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90-542
Porcupine	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73

See footnotes at end of table.

Table 26—Continued

Wild and Scenic Rivers System, June 1, 1975

River	Location	Segments	Sponsor	Status/Public Law
Priest	Idaho	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90–542
Rio Grande	Texas	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90–542
Saint Joe	Idaho	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90–542
Salmon	Idaho	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90–542
Salmon	Northern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Sheenjek	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Shepaug	Connecticut	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93–621
Sipsey Fork	Alabama	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93–621
Skagit	Washington	6	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90–542
Snake	Wyoming	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93–621
Suwannee [2]	Georgia, Florida	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90–542
Sweetwater	Wyoming	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93–621
Tinayguk	Northern Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Tuolumne	California	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93–621
Unalakleet [1]	Central Alaska	1	Interior	Proposed to Congress for inclusion by Secretary of the Interior on 12/18/73
Upper Iowa [2]	Iowa	1	Agriculture/Interior	Proposed for study 10/2/68 P.L. 90–542
Upper Mississippi	Minnesota	1	Agriculture/Interior	Proposed for study 1/3/75 P.L. 93–621

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[1] Of the 20 Alaskan rivers proposed for inclusion in the Wild and Scenic Rivers System by the Secretary of the Interior, these are the only four that do not lie within the boundaries of other proposed areas.

[2] Also recommended for preservation by the state.

CHAPTER 3

ENVIRONMENTAL CONDITIONS AND TRENDS

Since the Council was established in 1970, we have studied and reported on trends in air and water quality, on natural resources, and on many other environmental topics. This chapter discusses a number of nationwide environmental conditions and trends as well as some of their causes. We describe progress in the nation's efforts to protect the environment and discuss the more persistent and emerging problems. The topics include air and water quality, hazardous pollutants, living resources, the human population, energy technology trends, and other environmental data.

AIR QUALITY

The Clean Air Amendments of 1970 set mid-1975 as the deadline for achieving public health (primary) standards for ambient air quality.[1] Although air quality in the United States is better today than it was in 1970, the deadline was not fully met, and air pollution levels at many locations still range above the primary standards.

National ambient air quality standards have been designated for six major pollutants—total suspended particulates, sulfur dioxide, carbon monoxide, photochemical oxidants, nitrogen dioxide, and hydrocarbons—the "criteria" pollutants. They are described in Table 1. As of mid-1975, the standard levels had been fully achieved in only

Table 1

Major Air Pollutants [1]

Pollutant	Characteristics	Principal sources	Principal effects	Controls	National ambient standards [1,3] (in micrograms per cubic meter)
Total suspended particulates (TSP)	Any solid or liquid particles dispersed in the atmosphere, such as dust, pollen, ash, soot, metals, and various chemicals; the particles are often classified according to size as settleable particles: larger than 50 microns; aerosols: smaller than 50 microns; and fine particulates: smaller than 3 microns	Natural events such as forest fires, wind erosion, volcanic eruptions; stationary combustion, especially of solid fuels; construction activities; industrial processes; atmospheric chemical reactions	Health: Directly toxic effects or aggravation of the effects of gaseous pollutants; aggravation of asthma or other respiratory or cardiorespiratory symptoms; increased cough and chest discomfort; increased mortality Other: Soiling and deterioration of building materials and other surfaces, impairment of visibility, cloud formation, interference with plant photosynthesis	Cleaning of flue gases with inertial separators, fabric filters, scrubbers, or electrostatic precipitators; alternative means for solid waste reduction; improved control procedures for construction and industrial processes	Primary: Annual—75 24-hour=260 Secondary: Annual—60 24-hour=150 Alert: 24-hour=375
Sulfur dioxide (SO_2)	A colorless gas with a pungent odor; SO_2 can oxidize to form sulfur trioxide (SO_3), which forms sulfuric acid with water	Combustion of sulfur-containing fossil fuels, smelting of sulfur-bearing metal ores, industrial processes, natural events such as volcanic eruptions	Health: Aggravation of respiratory diseases, including asthma, chronic bronchitis, and emphysema; reduced lung function; irritation of eyes and respiratory tract; increased mortality	Use of low-sulfur fuels; removal of sulfur from fuels before use; scrubbing of flue gases with lime or catalytic conversion	Primary: Annual—80 24-hour=365 Alert: 24-hour=800

			Other: Corrosion of metals; deterioration of electrical contacts, paper, textiles, leather, finishes and coatings, and building stone; formation of acid rain; leaf injury and reduced growth in plants			
Carbon monoxide (CO)	A colorless, odorless gas with a strong chemical affinity for hemoglobin in blood	Incomplete combustion of fuels and other carbon-containing substances, such as in motor vehicle exhausts; natural events such as forest fires or decomposition of organic matter	Health: Reduced tolerance for exercise, impairment of mental function, impairment of fetal development, aggravation of cardiovascular diseases Other: Unknown	Automobile engine modifications (proper tuning, exhaust gas recirculation, redesign of combustion chamber); control of automobile exhaust gases (catalytic or thermal devices); improved design, operation, and maintenance of stationary furnaces (use of finely dispersed fuels, proper mixing with air, high combustion temperature)	Primary: Alert:	8-hour=10,000 1-hour=40,000 8-hour=17,000

See footnotes at end of table.

Table 1—Continued

Major Air Pollutants [1]

Pollutant	Characteristics	Principal sources	Principal effects	Controls	National ambient standards [1,3] (in micrograms per cubic meter)
Photochemical oxidants (O_x)	Colorless, gaseous compounds which can comprise photochemical smog, e.g., ozone (O_3), peroxyacetyl nitrate (PAN), aldehydes, and other compounds	Atmospheric reactions of chemical precursors under the influence of sunlight	Health: Aggravation of respiratory and cardiovascular illnesses, irritation of eyes and respiratory tract, impairment of cardiopulmonary function Other: Deterioration of rubber, textiles, and paints; impairment of visibility; leaf injury, reduced growth, and premature fruit and leaf drop in plants	Reduced emissions of nitrogen oxides, hydrocarbons, possibly sulfur oxides	Primary: 1-hour=160 Alert: 1-hour=200
Nitrogen dioxide (NO_2)	A brownish-red gas with a pungent odor, often formed from oxidation of nitric oxide (NO)	Motor vehicle exhausts, high-temperature stationary combustion, atmospheric reactions	Health: Aggravation of respiratory and cardiovascular illnesses and chronic nephritis Other: Fading of paints and dyes, impairment of visibility, reduced growth and premature leaf drop in plants	Catalytic control of automobile exhaust gases, modification of automobile engines to reduce combustion temperature, scrubbing flue gases with caustic substances or urea	Primary: Annual=100 Alert: 24-hour=282 1-hour=1,130

Hydrocarbons (HC)	Organic compounds in gaseous or particulate form, e.g., methane, ethylene, and acetylene	Incomplete combustion of fuels and other carbon-containing substances, such as in motorvehicle exhausts; processing, distribution, and use of petroleum compounds such as gasoline and organic solvents; natural events such as forest fires and plant metabolism; atmospheric reactions	Health: Suspected contribution to cancer Other: Major precursors in the formation of photochemical oxidants through atmospheric reactions	Automobile engine modifications (proper tuning, crankcase ventilation, exhaust gas recirculation, redesign of combustion chamber); control of automobile exhaust gases (catalytic or thermal devices); improved design, operation, and maintenance of stationary furnaces (use of finely dispersed fuels, proper mixing with air, high combustion temperature); improved control procedures in processing and handling petroleum compounds	Primary: 3-hour=160

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[1] Pollutants for which national ambient air quality standards have been established.

[2] Primary standards are intended to protect against adverse effects on human health. Secondary standards are intended to protect against adverse effects on materials, vegetation, and other environmental values.

[3] The federal episode criteria specify that meteorological conditions are such that pollutant concentrations may be expected to remain at these levels for 12 or more hours or to increase; in the case of oxidants, the situation is likely to reoccur within the next 24 hours unless control actions are taken.

Source: Based on information compiled by Enviro Control, Inc.

91 of the nation's 247 Air Quality Control Regions. At monitoring sites in nearly two-thirds of the regions, the pollution levels designated by the standards were still being exceeded (violated) for one or more pollutants. The standards are exceeded for suspended particulates in 118 of the 247 regions, for sulfur dioxide in 34 regions, carbon monoxide in 69 regions, oxidants in 79 regions, and nitrogen dioxide in 16 regions, according to EPA's estimates.[2]

The highest levels of particulates and sulfur oxides, the major pollutants from stationary sources (smokestacks), occur mainly in the Northeastern and North Central states. California continues to have the most severe automotive pollution problems. Occurrences of poor air quality are by no means restricted to any region or state, however. In such widely separated large cities as Los Angeles, Chicago, and Philadelphia, primary standards for all the criteria pollutants are still exceeded at times. There are also problems in many small cities and in rural areas.

Of the nation's 20,000 largest stationary sources which collectively account for about 85 percent of all stationary source pollution, 15,600 were in compliance with emission regulations or were meeting compliance schedules by mid-1975.[3]

Efforts to reduce air pollution have encountered a number of obstacles. Scientific knowledge and available technological and legal tools are sometimes insufficient. Moreover, the nation's economic and energy difficulties are not always compatible with environmental goals. Some facilities have been granted extensions or variances which permit the burning of coal or oil with a high sulfur content. The full effects of such variances on ambient air quality are still uncertain.

Yet it is evident that the nation's efforts to improve air quality have accomplished a great deal in the relatively short period of 5 years. This section describes many of these accomplishments but also some undesirable conditions as well. A discussion of the nation's air monitoring data base and efforts to improve the reporting and interpretation of data is also included.

The main factors which govern ambient air pollution levels are:

- Types and quantities of *pollutants produced* by human activities and natural sources
- *Controls* used to reduce emissions of pollutants
- Geographical *location* of pollution sources and of emissions over a given time period
- *Dispersal and movement* of pollutants, which depend on meteorological conditions and topography
- *Various chemical reactions* of pollutants in the atmosphere, often resulting in the formation of different types of pollutants
- *Processes by which pollutants are removed* from the atmosphere, such as gravity and precipitation.

The first two of these factors determine the emissions that occur; the others determine how the emissions affect air quality.

"CRITERIA" POLLUTANTS

Emissions

Between 1940 and 1970, the total nationwide emissions of all the major regulated air pollutants grew substantially—controllable particulate emissions increased about 15 percent, sulfur dioxide increased about 50 percent, carbon monoxide and hydrocarbon emissions more than doubled, and nitrogen oxide emissions quadrupled.[4]

Since 1970, however, air pollution control programs appear to be stemming that growth. The estimated total nationwide emissions of particulates and carbon monoxide have been reduced significantly, and the other major regulated pollutants have remained near 1970 levels. Figure 1 shows that between 1970 and 1974, particulate emissions dropped about 29 percent, sulfur dioxide declined 8 percent, carbon monoxide dropped 12 percent, and hydrocarbon emissions declined about 5 percent. On the other hand, nitrogen oxide emissions have increased an estimated 10 percent over the same period.

Figure 1 represents EPA's latest and most confident estimates. They are the result of calculations, in contrast to the direct measurements used to characterize ambient air quality. Different calculating techniques, data sources, working assumptions, and definitions can lead to different estimates. The techniques used to calculate these 1970–74 emissions differ from those used for 1940–70. Consequently, although recent emissions appear lower, the pre-1970 estimates are not truly comparable with the post-1970 calculations. On the other hand, the recent estimates are based on the best available common data sources, uniform estimation methods, and consistent assumptions. When some data were not available, projections were substituted on the basis of industry forecasts, economic indicators, and extrapolations from previous years' data.

Automobiles and other transportation modes produce most of the carbon monoxide, the largest pollutant in terms of weight. Transportation sources also contribute nearly one-half the total hydrocarbons and nitrogen oxides—the major chemical precursors of photochemical oxidants that we know as smog. Two of the most important factors determining these releases are the emission controls on highway vehicles and the counteracting growth in motor vehicle fuel consumption.

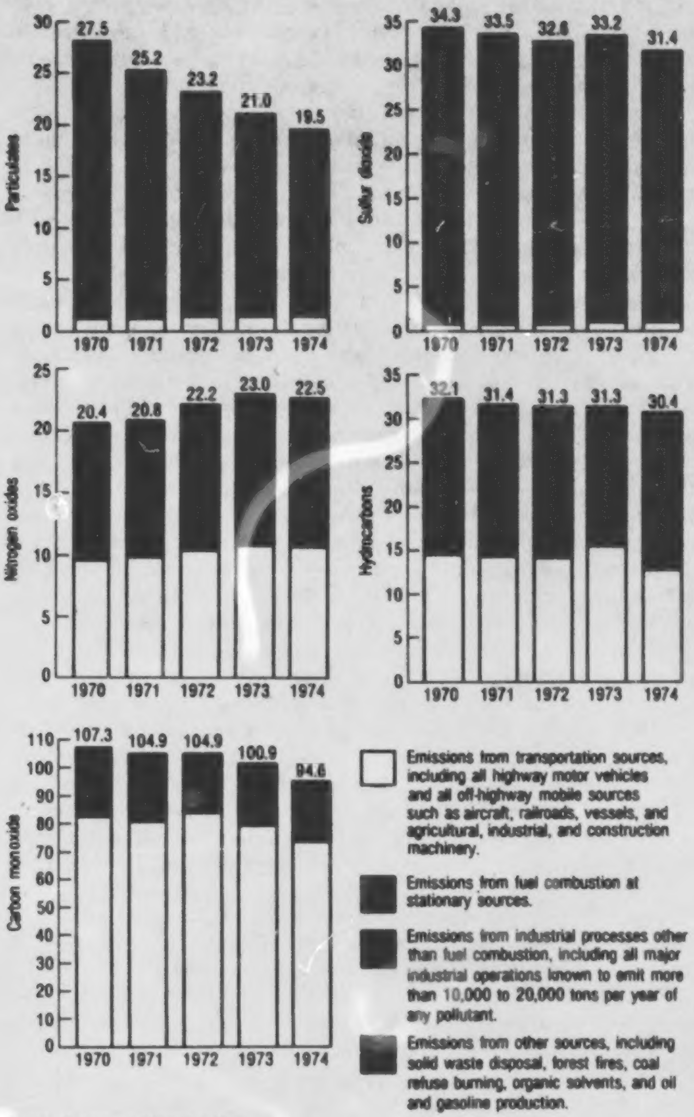
Although controls have not yet significantly reduced nitrogen oxide emissions, carbon monoxide and hydrocarbon emissions per vehicle mile are progressively lower each year, as shown in Figure 2. The standards in effect for the 1975 model automobiles, for example, represent a per vehicle reduction of over 80 percent in carbon monoxide and hydrocarbons from uncontrolled levels.

The improvements achieved in automotive emissions controls have been offset somewhat by increasing motor vehicle use and fuel consumption, so that total nationwide reductions are not nearly so high as they are per vehicle mile. Between 1970 and 1973, motor vehicle

Figure 1

Estimated Emissions of Major Air Pollutants, Nationwide, 1970-74

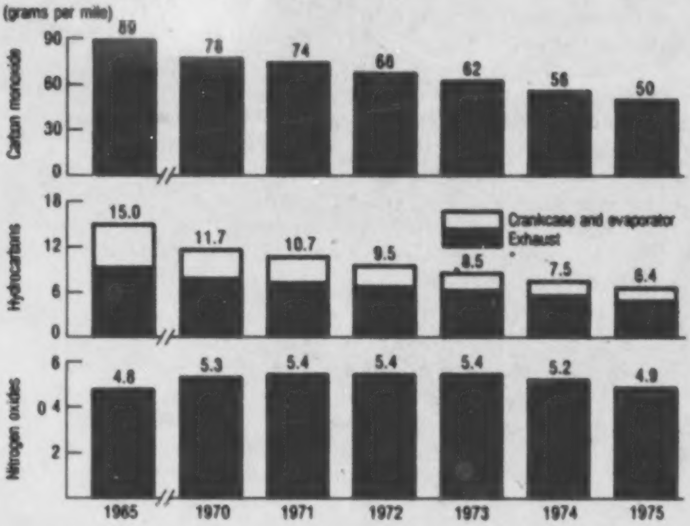
(millions of tons per year)



Source: Environmental Protection Agency.

Figure 2

Estimated Average Emissions per Mile from Highway Vehicles, 1965-75



Source: Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, AP-42* (Washington, D.C.: Government Printing Office, 1973), and unpublished data.

fuel usage increased about 20 percent. In 1974, there was a slight reduction of about 1 percent, apparently because of fuel shortages and the economic situation. Even this slight reduction gives visibility to the effectiveness of improved controls. Although many older cars with no controls are still being driven, over 7 percent less carbon monoxide was emitted from all transportation sources in 1974 alone.

Combustion of fossil fuels at stationary sources—residential furnaces, electric powerplants, and industrial facilities—accounts for most of the sulfur dioxide, nearly one-half the nitrogen oxides, and a large portion of the particulate matter emitted nationwide (Figure 1). From 1970 to 1974, particulate and sulfur dioxide emissions from these sources were substantially reduced, about 29 percent for particulates and 10 percent for sulfur dioxide. Over the same period, however, nitrogen oxides emissions from stationary fuel combustion increased an estimated 9 percent. The reductions in particulates and sulfur dioxide were due mostly to improved stack controls, a decline in coal consumption by all sources except electric powerplants, and a reduction in the average sulfur content of fuels used by electric utilities.

In the category of industrial processes other than fuel combustion, Figure 1 shows that approximately 80 other industrial processes generate more than one-half the particulates and important fractions of the total sulfur dioxide, carbon monoxide, and hydrocarbon emissions. The most significant change in this category has been an estimated 30 percent reduction in particulates. This was due largely to improved controls in the mineral products and metals industries.

Emissions from other sources, such as solid waste disposal, forest fires, coal refuse burning, use of organic solvents, and production of oil and gasoline round out the nationwide estimates (Figure 1). Nearly half the nation's hydrocarbon emissions result from solvent use and from the storage, shipping, and handling of gasoline and other petroleum derivatives. Miscellaneous activities in this category also produce significant amounts of particulates and carbon monoxide. Reductions in solid waste burning from 1970 to 1974 were partly responsible for an estimated 43 percent drop in particulate emissions and a 38 percent decline in carbon monoxide emissions from this category of "other" sources.

Ambient Air Monitoring

Reducing emissions is no guarantee that ambient air quality will improve everywhere. Air pollution levels also depend upon where and when the emissions occur as well as on meteorological and other factors which determine the dispersal rate of pollutants and the physical and chemical changes that they undergo in the atmosphere.

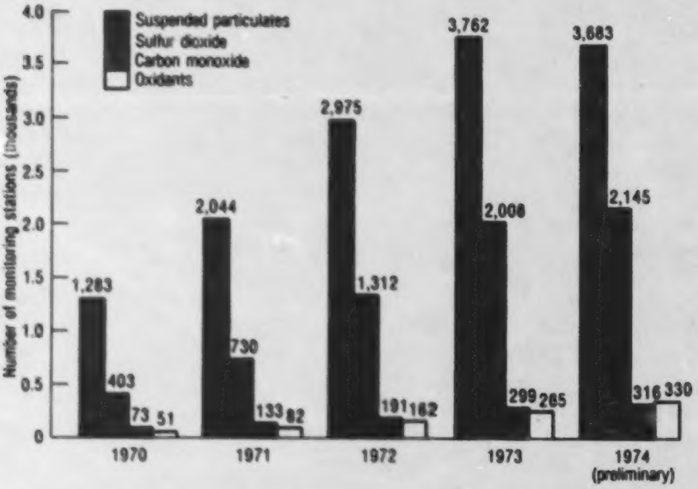
To measure the effects of such factors and the resulting patterns in ambient air pollution levels, more than 6,000 air monitoring stations are operated in the United States—mostly by state and local agencies. Data for each calendar quarter are reported to EPA's National Aerometric Data Bank at Research Triangle Park, North Carolina. The data are then screened, assimilated, and analyzed for EPA's nationwide and regional summaries.

By far the most monitored air pollutants are suspended particulates and SO_2. Figure 3 shows the number of stations reporting at least minimal data in 1970–74. CO and photochemical oxidant monitoring is much less extensive but is increasing each year. Little monitoring for ambient nitrogen oxides or hydrocarbons takes place, primarily because it is the oxidants that they form in the atmosphere that are of primary interest. In addition, there has been no approved analytical reference method for nitrogen dioxide.

EPA's air monitoring plans called for each of the 247 Air Quality Control Regions to have all required monitoring stations operational by July 1, 1974. Basically, the plans required that the pollutants measured most extensively by the state monitoring networks correspond to the assessed or anticipated severity of each pollutant—its priority classification—in each region. The classifications are given in Table 2. As of mid-1973, 92 percent of the required state monitoring activity was already operational for suspended particulates; for sulfur dioxide 24-hour samples, 77 percent; for sulfur dioxide continuous samples, 64 percent; carbon monoxide, 77 percent; and oxidants, 65 percent.

Figure 3

Monitoring Stations Which Reported at Least Minimal Data, 1970-74[1]



[1] Minimal data consist of at least three 24-hour samples or 400 hourly values.
Source: Environmental Protection Agency.

Table 2

EPA Priority Classifications of the Nation's 247 Air Quality Control Regions [1]

	Number of regions			
	Priority I (most severe)	Priority II	Priority III (least severe)	Total
Suspended particulates	120	70	57	247
Sulfur dioxide	60	41	146	247
Carbon monoxide	30	—	217	247
Oxidants	55	—	192	247
Nitrogen dioxide	5	—	242	247

[1] Classifications were determined on the basis of assessed or anticipated severity of each pollutant in each region.

Source: Environmental Protection Agency.

Previous CEQ descriptions of air quality were based largely on data collected by the small, thinly spread air monitoring networks operated by the federal government, the National Air Surveillance Network (NASN) and the Continuous Air Monitoring Program

(CAMP). Beginning this year, however, the Council is making more use of the much larger and growing national data base of measurements collected mostly by state and local networks and compiled by EPA. The federal (NASN and CAMP) data bases remain our most important sources of consistent, standardized information about long-term trends and "noncriteria" pollutants (see Table 9) and are in fact also included in the National Aerometric Data Bank. However, most of the operations of these federal monitoring networks have been decentralized to states and EPA regions. The national data base is becoming more useful, largely because of the monitoring requirements of the Clean Air Act of 1970 and the cooperation of all levels of government.

Caution is necessary in evaluating data on nationwide trends because the data base is changing and has not yet stabilized; new monitoring stations are still being added. Most monitoring sites are located in heavily populated or industrialized areas—the identified air pollution problem areas. Some sites experience nontypical meteorological conditions in some years, affecting local measurements. Some state and local data cannot be used in national summaries for such reasons as late submission to EPA or inadequate measurements. In addition, quality controls on monitoring methods are often insufficient, and uniform siting criteria for monitoring stations need to be improved. This point is discussed later.

For all these reasons, the nationwide summaries presented below should be viewed only as *indicators* of air quality conditions and trends, useful for descriptions at a nationwide and regional level but compiled from a very large, heterogeneous, and changing national data base.

Ambient Air Quality

Although air pollution levels still exceed (violate) federal ambient standards in many parts of the United States, ambient levels of suspended particulates and sulfur dioxide have mostly been improving. These improvements may be examined by using three basic kinds of indicators:

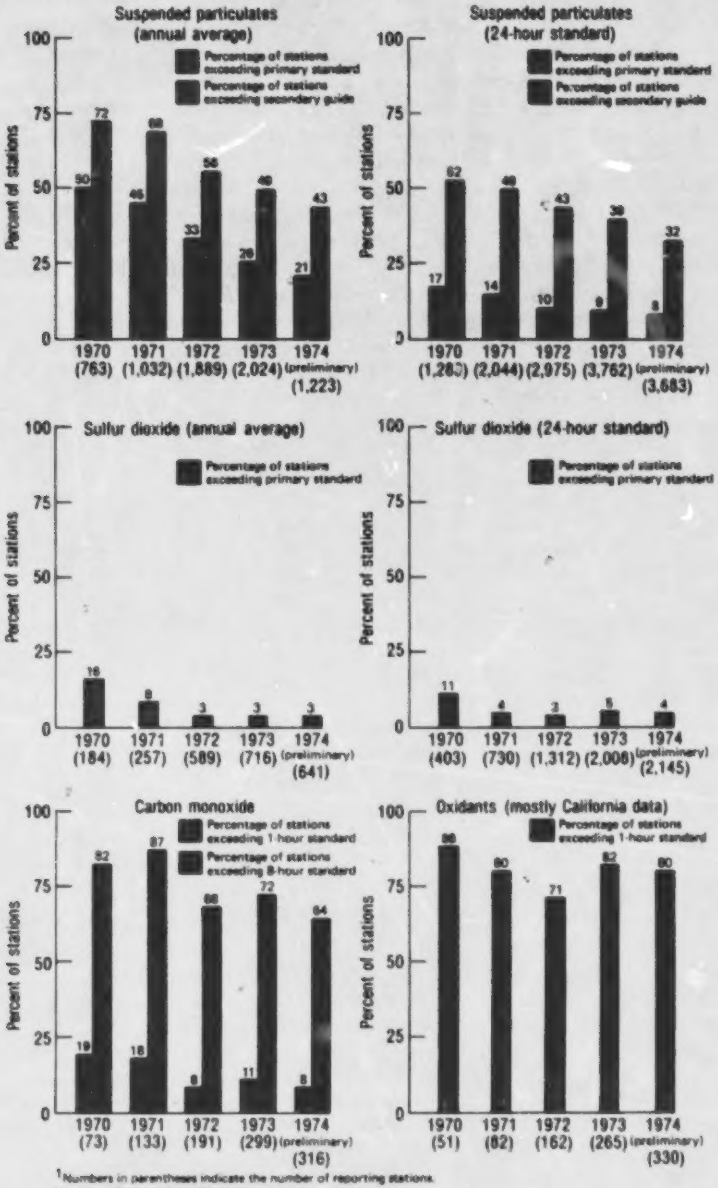
- The percentage of monitoring sites at which ambient air quality standards were exceeded each year (Figure 4)
- The percentage of Air Quality Control Regions in which the standards were exceeded (Figure 5)
- The national and regional trends in average levels of the pollutants (Figures 6 and 7).

For the pollutants that are monitored less extensively, such as carbon monoxide and photochemical oxidants (smog), use of the indicators must be somewhat modified and restricted.

Suspended Particulates Applying the first indicator to suspended particulates, Figure 4 shows the number of air monitoring stations where air pollution levels exceeded the national ambient air quality

Figure 4

Monitoring Stations at Which Ambient Standards Were Exceeded, 1970-74[1]



[1] Numbers in parentheses indicate the number of reporting stations.

Source: Environmental Protection Agency.

standards (see Table 1) as a percentage of the total number of stations reporting data that satisfied EPA's criteria for either valid or minimal data.* In 1973, for example, the primary (public health) annual standard for suspended particulate levels was still being exceeded at 26 percent or 521 of the 2,024 monitoring stations reporting a full year's valid data, and the secondary annual standard—designated for protection of vegetation, materials, and other environmental values—was being exceeded at 49 percent or 996 of the 2,024 sites. Preliminary data for 1974 indicate improvements to 21 percent for the primary and 43 percent for the secondary standards. The daily maximum standards for particulate levels were exceeded at fewer sites that reported sufficient data for at least one calendar quarter of 1973, and the percentages for particulates have consistently declined each year since 1970. But in 1973, some monitoring sites reported both annual average and daily maximum particulate levels that ranged above 300 percent of the primary standards.[8]

Problem locations are widely dispersed throughout the United States, and many locations still experience high particulate levels as shown in Figure 5. For example, although the primary 24-hour standard for suspended particulates was exceeded at only 9 percent of the reporting stations in 1973 (Figure 4), that 9 percent was scattered over 51 percent of the regions that reported at least one quarter's valid data (Figure 5). Moreover, in a large proportion of these regions, the more serious federal air pollution episole alert levels were exceeded in addition to the primary standard levels, suggesting that in a large percentage of the remaining problem locations within these regions, the problems are sometimes severe. Further, although Priority I (most severe) regions generally experience the highest levels of suspended particulates, as expected, problems in the Priority II and III regions are by no means negligible. In fact, some sites in Priority II and III regions reported 1973 particulate levels that ranged above 200 percent of the daily maximum primary standard.[6] It should be noted that exceeding a designated alert level does not necessarily mean that an alert was declared (see Table 1).

Any basic environmental indicators have limitations, and the preceding examples are not exceptions to this rule. For instance, because more monitoring stations report to EPA each year, the trends depicted in Figure 4, although accurate as described, are not scientifically rigorous. If it were true, for example, that all the new stations were located where the primary annual particulate standard is never exceeded, the improvement shown in Figure 4 could be a function of the changes in the data base. In other words, if one-half of the stations observed violations in 1970 and if only one-fourth of, say, twice as many stations reported violations in 1973

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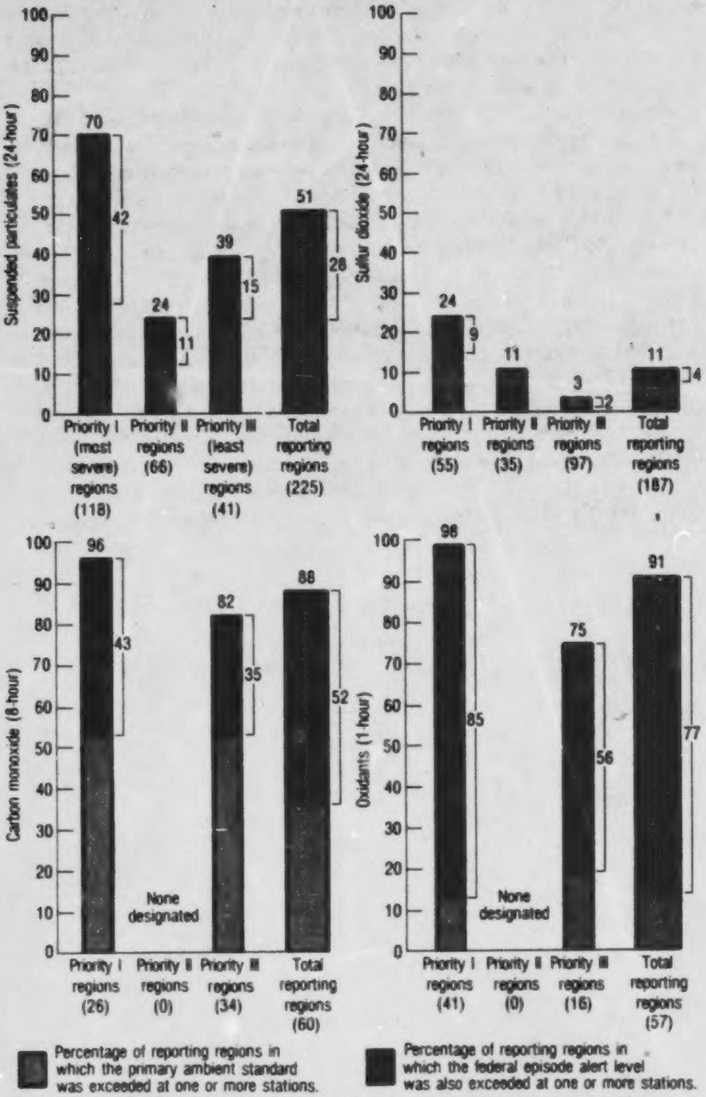
*"Valid" data from a monitoring station must consist of at least 75 percent of all scheduled hourly or 24-hour samples during each of a year's four calendar quarters. "Minimal" data from a monitoring station must consist of at least three 24-hour samples or 400 hourly values in a given year.

Figure 5

Reporting Regions in Which Ambient Standards Were Exceeded,[1] 1973



[1] There are 247 Air Quality Control Regions. An air pollution episode alert is not always declared when the designated level is exceeded.

Source: Based on Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1973* (Washington, D.C.: Government Printing Office, 1974), Figures 3-2, 3-5, 3-6, 3-7, and 3-8.

(Figure 4), then one might legitimately wonder whether the same stations continued to experience problems and no improvements were in fact made.

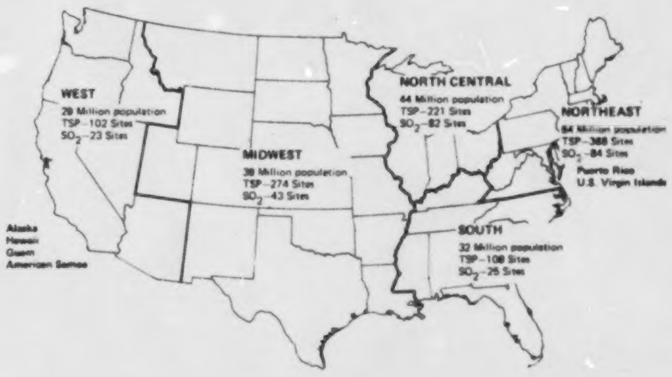
However, these improvements are valid, and the indicators are useful so long as their limitations are understood. Because EPA's Clean Air Act monitoring plans require most extensive monitoring in the Priority I regions, stations new to the National Aerometric Data Bank represent a fairly well-balanced group, oriented toward areas of high population density.

To corroborate the trends, a third indicator may be used. It involves a constant group of monitoring stations. Figure 6 shows their geographic distribution. These 1,073 stations provided enough data for analyses of average annual particulate levels from 1970 to 1974.

The trends for suspended particulates are illustrated in Figure 7. Between 1970 and 1973, the nationwide quarterly average for suspended particulate levels declined about 14 percent. Since then it appears to have leveled off somewhat. Downward trends are apparent regionally, although many stations are still experiencing particulate levels that exceed the standards. These improvements are consistent with observations for 1960–72. It should be noted, however, that more than 90 percent of the monitoring sites that qualified for inclusion are located in the more populous areas of the country. Slightly less than 4 percent of these sites are designated by EPA as source-oriented. The remaining are considered "background" stations, mostly rural. The composite annual average for suspended

Figure 6

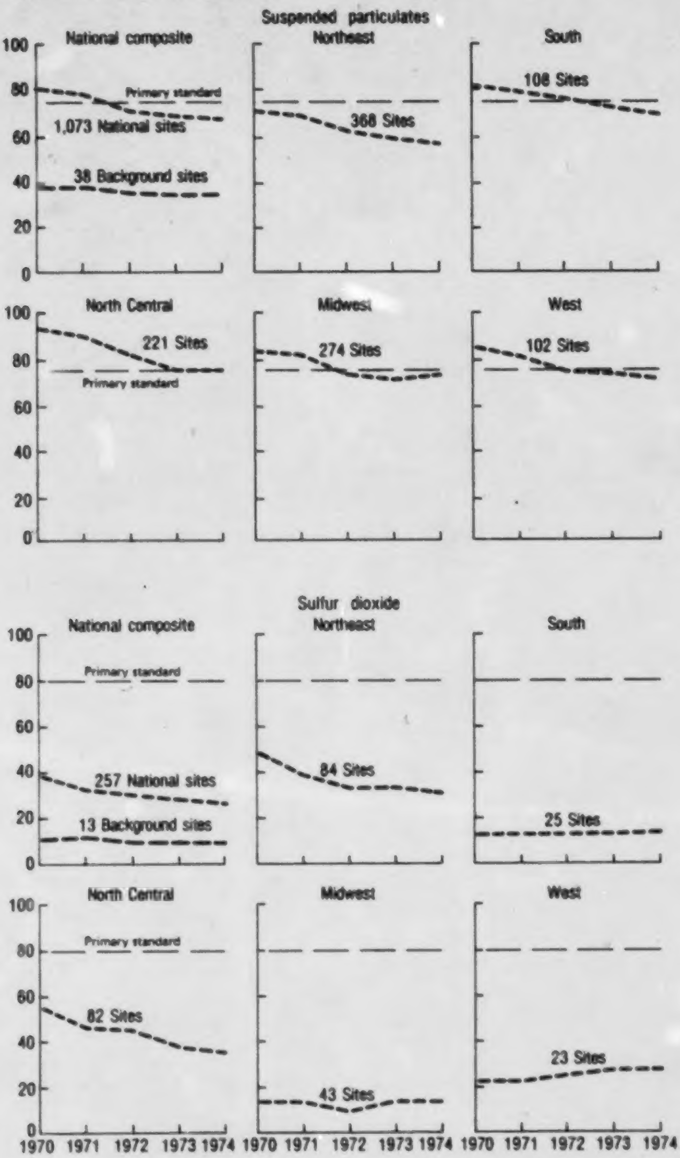
Distribution of Monitoring Sites Meeting EPA Trend Criteria for Total Suspended Particulates and Sulfur Dioxide, 1970–74


WEST
29 Million population
TSP–102 Sites
SO2–23 Sites
MIDWEST
38 Million population
TSP–274 Sites
SO2–43 Sites
NORTH CENTRAL
44 Million population
TSP–221 Sites
SO2–82 Sites
NORTHEAST
84 Million population
TSP–388 Sites
SO2–84 Sites
Puerto Rico
U.S. Virgin Islands
SOUTH
32 Million population
TSP–108 Sites
SO2–25 Sites
Alaska
Hawaii
Guam
American Samoa

Source: Environmental Protection Agency.

Figure 7

Average Levels of Total Suspended Particulates and Sulfur Dioxide, 1970-74



Source: Environmental Protection Agency.

particulates at 38 background sites improved slightly between 1970 and 1974.

On the basis of EPA's most recent projections, 118 Air Quality Control Regions were not expected to meet the national ambient air quality standards by the statutory attainment schedule of mid-1975. Listed in Table 3 are the 33 regions for which nonattainment appears to be caused by "uncontrollable" sources of particulates, such as fugitive dust, which includes desert dust storms and dust blown from farms, unpaved roads, and construction areas. The other 85 regions that are not expected to meet the deadline are listed in Table 4.

Sulfur Dioxide The same basic indicators of suspended particulate trends may be employed to describe national sulfur dioxide trends. Of all the regulated major air pollutants, sulfur dioxide has improved the most (Figure 4). By 1973, the annual average and maximum daily primary standards for sulfur dioxide were being exceeded at only 3 and 5 percent of the reporting stations, respec-

Table 3

Air Quality Control Regions Expected To Exceed the National Standards for Total Suspended Particulates by the Statutory Deadline Because of Fugitive Dust

Air quality control region	Principal city [1]	Air quality control region	Principal city [1]
12	Silver City, New Mexico	89	Mason City, Iowa
13	Kingman, Arizona	92	Des Moines, Iowa
14	Flagstaff, Arizona	95	Topeka, Kansas
15	Phoenix, Arizona	96	Salina, Kansas
18	Marion, Arkansas	99	Wichita, Kansas
20	Newport, Arkansas	146	Grand Island, Nebraska
23	Death Valley, California	147	Ely, Nevada
26	Eureka, California	148	Reno, Nevada
28	Sacramento, California	152	Albuquerque, New Mexico
31	Fresno, California	153	El Paso, Texas
33	Lancaster, California	187	Woodward, Oklahoma
36	Denver, Colorado	205	Rapid City, South Dakota
37	Fort Collins, Colorado	207	Knoxville, Tennessee
38	Pueblo, Colorado	213	Brownsville, Texas
40	Craig, Colorado	222	Danville, Virginia
85	Omaha, Nebraska	226	Roanoke, Virginia
88	Cedar Rapids, Iowa		

[1] The term "principal city" refers to the principal population center in the particular AQCR and has no relation to the actual locations of air quality measurements which violate NAAQS. For interstate AQCR's, "principal city" is the principal city in that state portion which is not considered likely to attain NAAQS by the statutory attainment date. In cases where more than one state portion of an interstate AQCR is considered unlikely to attain NAAQS by the statutory attainment date, the principal city in the AQCR as a whole is indicated.

Source: Environmental Protection Agency.

Table 4

Air Quality Control Regions Expected To Exceed the National Standards for Total Suspended Particulates by the Statutory Deadline [1]

Air quality control region	Principal city [2]	Air quality control region	Principal city [2]
05	Pensacola, Florida	124	Toledo, Ohio
07	Huntsville, Alabama	126	Traverse City, Michigan
16	Little Rock, Arkansas	128	Rochester, Minnesota
17	Fort Smith, Arkansas	129	Duluth, Minnesota
22	Shreveport, Louisiana	131	Minneapolis, Minnesota
24	Los Angeles, California	132	Fergus Falls, Minnesota
29	San Diego, California	133	Wilmar, Minnesota
42	Hartford, Connecticut	137	Jefferson City, Missouri
45	Philadelphia, Pennsylvania	142	Helena, Montana
47	Washington, D.C.	143	Miles City, Montana
49	Jacksonville, Florida	144	Missoula, Montana
50	Miami, Florida	145	Lincoln, Nebraska
52	Tampa, Florida	151	Scranton, Pennsylvania
55	Chattanooga, Tennessee	159	Burlington, Vermont
65	Burlington, Illinois	173	Dayton, Ohio
67	Chicago, Illinois	174	Cleveland, Ohio
68	Dubuque, Iowa	175	Mansfield-Marion, Ohio
69	Davenport, Iowa	176	Columbus, Ohio
70	St. Louis, Missouri	178	Youngstown, Ohio
73	Beloit, Wisconsin	179	Marietta, Ohio
75	Springfield, Illinois	180	Sandusky, Ohio
77	Henderson, Kentucky	181	Steubenville, Ohio
78	Louisville, Kentucky	184	Oklahoma City, Oklahoma
79	Cincinnati, Ohio	186	Tulsa, Oklahoma
80	Indianapolis, Indiana	195	Altoona, Pennsylvania
84	Terre Haute, Indiana	196	Harrisburg, Pennsylvania
86	Sioux City, Iowa	197	Pittsburgh, Pennsylvania
87	Sioux Falls, South Dakota	199	Charleston, South Carolina
90	Spencer, Iowa	208	Nashville, Tennessee
91	Iowa City, Iowa	211	Amarillo, Texas
94	Kansas City, Missouri	214	Corpus Christi, Texas
97	Great Bend, Kansas	215	Dallas, Texas
98	Coffeyville, Kansas	216	Houston, Texas
100	Dodge City, Kansas	217	San Antonio, Texas
101	Hazard, Kentucky	220	Salt Lake City, Utah
103	Ashland, Kentucky	223	Norfolk, Virginia
115	Baltimore, Maryland	225	Richmond, Virginia
118	Worchester, Massachusetts	234	Charleston, West Virginia
119	Boston, Massachusetts	238	Wausau, Wisconsin
120	Providence, Rhode Island	239	Milwaukee, Wisconsin
121	Great Falls, Montana	243	Sheridan, Wyoming
122	Flint, Michigan	246	Guam
123	Detroit, Michigan		

[1] Excludes AQCR's that will exceed standards because of fugitive dust.

[2] "Principal city" refers to the principal population center in the particular AQCR and has no relation to the actual locations of air quality measurements that violate NAAQS. For interstate AQCR's, "principal city" is the principal city in that state portion which is not considered likely to attain NAAQS by the statutory attainment date. In cases where more than one state portion of an interstate AQCR is considered unlikely to attain NAAQS by the statutory attainment date, the principal city in the AQCR as a whole is indicated.

Source: Environmental Protection Agency.

tively. Preliminary 1974 data are similar. The problem locations were distributed among 11 percent of the reporting regions (Figure 5).

By no means do these figures warrant complacency, however. In five of the reporting regions in 1973, ambient sulfur dioxide levels exceeded 300 percent of the primary 24-hour standard. Moreover, only 130 of the regions reported a full year's data from any monitoring stations in 1973. These included only about one-half the regions assigned Priority I and II severity status for sulfur dioxide, so the situation may well be worse than the data indicate. Many of the monitoring sites near large combustion sources like coal-fired powerplants were just established or were not yet operational.[7]

The national average sulfur dioxide levels dropped 25 percent from 1970 to 1974, as shown in Figure 7, continuing a pattern begun the decade before. In many urban areas improvements were even better.

That the trends seem to be leveling off is not entirely surprising because ambient sulfur dioxide standards are being met at most monitoring sites. Higher sulfur dioxide levels were observed in some regions in 1974, apparently resulting from the switch to coal and from use of higher sulfur fuels in powerplants and other major stationary emissions sources.[8] Thirty-four regions were not expected to meet the May 31 deadline for controlling sulfur dioxide; they are listed in Table 5.

Carbon Monoxide Although the total weight of carbon monoxide emissions is more than three times higher than that of any other major pollutant (Figure 1), carbon monoxide is generally a potential health hazard only where emissions are highly concentrated, as in heavy urban traffic. Because carbon monoxide is essentially a localized pollutant, it is usually measured more selectively and much less extensively than suspended particulates or sulfur dioxide (Figure 3). Only 30 of the nation's Air Quality Control Regions are Priority I for carbon monoxide; the remainder are Priority III (Table 2).

Carbon monoxide levels cannot be summarized for the nation by examining trends in the composite average of its sparsely measured levels. Moreover, the patterns of some of its other indicators (Figures 4 and 5) must be viewed very cautiously.

The 1-hour ambient standard for carbon monoxide is exceeded at only about one-tenth of the monitoring sites that report data to EPA, but violations of the 8-hour standard are widespread. In 1973, 72 percent of the same reporting stations exceeded the 8-hour standard, although the preliminary 1974 data show a reduction to 64 percent (Figure 4). These 212 stations are located in 60 regions, nearly all of which experience levels above the 8-hour standard (Figure 5). The more severe federal air pollution episode alert level is also exceeded in most of these reporting regions. Significantly, 34 of the 60 problem regions had been classified as Priority III, meaning that they were not expected to be problem areas and in fact were not even required to measure carbon monoxide levels.

Table 5

Air Quality Control Regions Expected To Exceed National Standards for Sulfur Dioxide by the Statutory Deadline

Air quality control region	Principal city[1]	Air quality control region	Principal city[1]
007	Huntsville, Alabama	079	Cincinnati, Ohio
012	Hurley, New Mexico	080	Indianapolis, Indiana
024	Los Angeles, California	082	South Bend, Indiana
042	Hartford, Connecticut	083	Bloomington, Indiana
045	Philadelphia, Pennsylvania	084	Terre Haute, Indiana
047	Washington, D.C.	103	Huntington, West Virginia
052	Tampa, Florida	120	Providence, Rhode Island
062	Kellogg, Idaho[2]	122	Flint, Michigan
065	Burlington, Illinois	123	Detroit, Michigan
067	Chicago, Illinois	125	Lansing, Michigan
070	St. Louis, Missouri	131	Minneapolis, Minnesota
071	Dixon, Illinois	142	Helena, Montana
072	Paducah-Cairo, Illinois	209	Memphis, Tennessee
074	Carbondale, Illinois	216	Galveston, Texas
075	Springfield, Illinois	235	Clarksburg, West Virginia
077	Evansville, Indiana	239	Milwaukee, Wisconsin
078	Louisville, Kentucky[2]	246	Guam

[1] The term "principal city" refers to the principal population center in the particular AQCR and has no relation to the actual locations of air quality measurements which violate NAAQS. For interstate AQCR's, "principal city" is the principal city in that state portion which is not considered likely to attain NAAQS by the statutory attainment date. In cases where more than one state portion of an interstate AQCR is considered unlikely to attain NAAQS by the statutory attainment date, the principal city in the AQCR as a whole is indicated.

[2] Has 2-year extension from the statutory date.

Source: Environmental Protection Agency.

Although Figure 4 suggests some improvement in carbon monoxide levels since 1970, the sparseness and diversity of the monitoring sites necessitate a closer analysis. Most stations that consistently report carbon monoxide data are located in the Los Angeles and San Francisco Bay areas, New Jersey, New York, and Washington state. The average yearly percentage of individual measured values that have exceeded the 8-hour standard in each of these areas (another type of indicator) suggests that the standard is violated less than 1 percent of the time in the San Francisco Bay area and in New York, and substantial improvement has been noted at the other sites that report regularly.

The improving trends shown in Figure 8 reflect in part the emission reductions that have resulted from the federal motor vehicle emissions control program. In addition, in Los Angeles, the 1-hour composite carbon monoxide average, which has produced some of the nation's highest readings, declined 19 percent between 1970 and 1973.[9] The regions exceeding ambient standards for carbon monoxide are listed in Table 6.

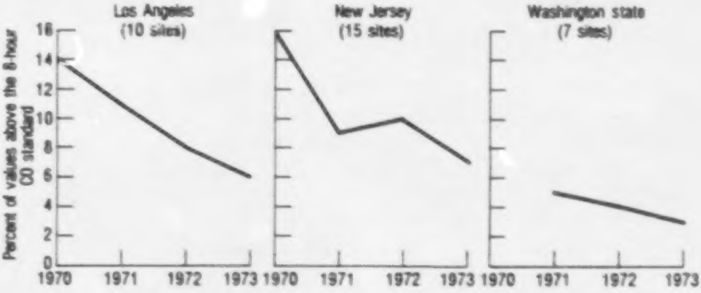
Photochemical Oxidants Ambient oxidant data are also too sparse and too regionally oriented to permit a meaningful nationwide summary. Oxidants are included in Figures 4 and 5 only for very cautious comparison with the other pollutants shown. Most of the oxidant monitoring sites that meet EPA validity criteria are in California; Figures 4 and 5, then, should be interpreted essentially as a California summary.

Recent improvement is indicated by the yearly maximum oxidant values measured (Figure 9); the only exceptions are the 1973 levels measured at four coastal sites in Los Angeles, but they have been attributed to unusual meteorological conditions.[10] As shown in the figure, the improvements are also apparent in the average number of oxidant values that exceeded the ambient standard in these same areas—again with the exception of coastal Los Angeles in 1973.

These California areas have regularly experienced oxidant problems in recent years. The modest improvements roughly parallel the

Figure 8

Annual Average Frequency of Carbon Monoxide Levels Exceeding the 8-Hour Standard, 1970-73



Source: Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1973* (Washington, D.C.: Government Printing Office, 1974), Figure 4-6.

Table 6

Air Quality Control Regions Exceeding National Standards for Carbon Monoxide in 1973 and/or 1974

Air quality control region	Principal urban area reporting violations	Air quality control region	Principal urban area reporting violations
004	Birmingham, Alabama	113	Cumberland, Maryland
008	Anchorage, Alaska [1]	115	Baltimore, Maryland (TCP) [3]
009	Fairbanks, Alaska (TCP) [2]	118	Worcester, Massachusetts
013	Las Vegas, Nevada	119	Boston, Massachusetts (TCP) [3]
015	Phoenix, Arizona [3]	120	Providence, Rhode Island (TCP) [3]
018	Memphis, Tennessee	121	Nashua, New Hampshire
024	Los Angeles, California (TCP) [3]	124	Toledo, Ohio
028	Sacramento, California (TCP) [3]	131	Minneapolis, Minnesota (TCP) [2]
029	San Diego, California (TCP) [3]	145	Lincoln, Nebraska
030	San Francisco, California (TCP) [3]	148	Reno, Nevada
031	Fresno, California (TCP) [3]	150	Atlantic City, New Jersey
032	San Luis Obispo, California	151	Phillipsburg, New Jersey [1]
033	Lancaster, California [1]	152	Albuquerque, New Mexico
036	Denver, Colorado (TCP) [3]	153	Las Cruces, New Mexico
042	Springfield, Massachusetts	157	Santa Fe, New Mexico
043	New York City, New York (TCP) [3]	158	Syracuse, New York
045	Philadelphia, Pennsylvania (TCP) [3]	159	Burlington, Vermont [1]
047	Washington, D.C. (TCP) [3]	160	Rochester, New York (TCP) [4]
056	Atlanta, Georgia	161	Schenectady, New York
060	Honolulu, Hawaii	162	Buffalo, New York [1]
062	Spokane, Washington (TCP) [2]	167	Charlotte, North Carolina
067	Chicago (Illinois (TCP) [3]	173	Dayton, Ohio
070	St. Louis, Missouri	174	Cleveland, Ohio
072	Paducah, Kentucky	176	Columbus, Ohio [1]
077	Owensboro, Kentucky	184	Oklahoma City, Oklahoma
078	Louisville, Kentucky	186	Tulsa, Oklahoma [1]
085	Omaha, Nebraska [1]	193	Portland, Oregon (TCP) [3]
092	Des Moines, Iowa	197	Pittsburgh, Pennsylvania (TCP) [3]
094	Kansas City, Kansas	206	Nashville, Tennessee
095	Topeka, Kansas [1]	216	Houston, Texas (TCP) [4]
099	Wichita, Kansas	220	Salt Lake City, Utah (TCP) [3]
102	Lexington, Kentucky [1]	223	Hampton, Virginia
103	Ashland, Kentucky	225	Richmond, Virginia
106	New Orleans, Louisiana	229	Seattle, Washington (TCP) [3]
		239	Milwaukee, Wisconsin

[1] Less than 20 percent above primary standards and thus probably not a problem at this time. (Additional CO reductions will occur as a result of the Federal Motor Vehicle Control Program.)

[2] Transportation Control Plan designed for carbon monoxide only.

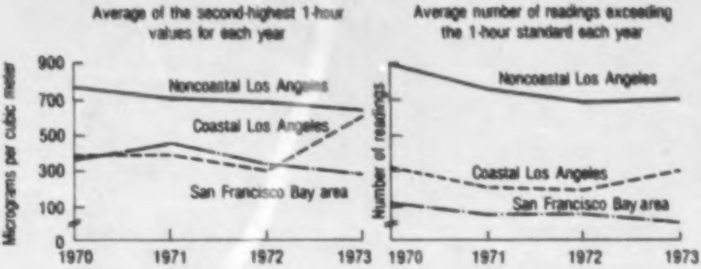
[3] Transportation Control Plan designated for both carbon monoxide and photochemical oxidants.

[4] Transportation Control Plan designed for photochemical oxidants only.

Source: Environmental Protection Agency.

Figure 9

Oxidant Levels in California, 1970-73



—— Noncoastal Los Angeles, 5 sites: Anaheim, Azusa, Lakebra, Reseda, and Redlands.
– – – Coastal Los Angeles, 4 sites: Downtown Los Angeles, West Los Angeles, Lennox, and Long Beach.
–·– San Francisco Bay Area, 6 sites: Fremont, Oakland, Pittsburgh, Redwood City, San Leandro, and San Rafael. The 1-hour standard is 160 micrograms per cubic meter.

Source: Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1973* (Washington, D.C.: Government Printing Office, 1974), Figure 4-4 and Table 4-6.

10 percent decline in total estimated hydrocarbon emissions over the same period.

Less than one-half of all manmade emissions of hydrocarbons and nitrogen oxides—the main precursors of oxidants—come from motor vehicles. Until recently, ozone and other oxidants were generally considered an air pollution problem only for the large urban areas because they were produced by photochemical reactions of locally emitted "reactive" hydrocarbons and oxides of nitrogen and were abated through controls on the auto emissions and transportation control programs. But during the past few years, oxidant levels exceeding the 1-hour ambient standard were found in some rural areas, far from any cities or other known major sources of hydrocarbon or nitrogen oxide emissions.

While studying air pollution damage to Christmas trees in western Maryland and eastern West Virginia in the summer of 1970, EPA investigators unexpectedly found rural oxidant levels frequently exceeding the 1-hour standard.[11] Additional studies carried out in Maryland, Pennsylvania, Ohio, and West Virginia showed that nearly all rural oxidants were ozone and that the problem was significant.[12] In the four rural areas shown in Figure 10, the ambient ozone standard was violated in 15 percent (Area 4, West Virginia) to 37 percent (Area 1, Maryland) of all measurements made during the study. In fact, the standard was even exceeded by the *average* of all afternoon and evening ozone levels measured at the Maryland site in 1973, as shown in Figure 11.

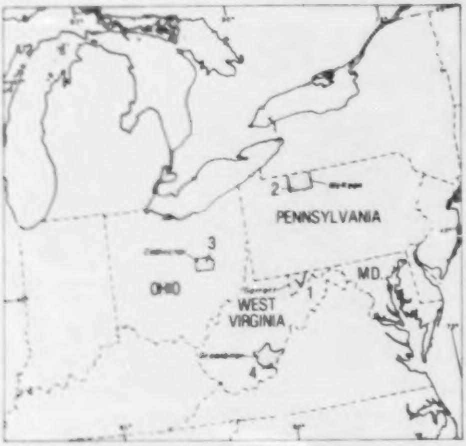
These rural conditions are not unique. In California, the ambient standard for ozone was exceeded more often at Indio than at any other site in the state, and Indio is 140 miles from Los Angeles. High ozone concentrations have also been observed in several nonurban areas in California and in Florida, New York, and Wisconsin.[13]

Smog obscures the mountains in San Bernardino, California.

Figure 10

Eastern Study Areas for Rural Ozone

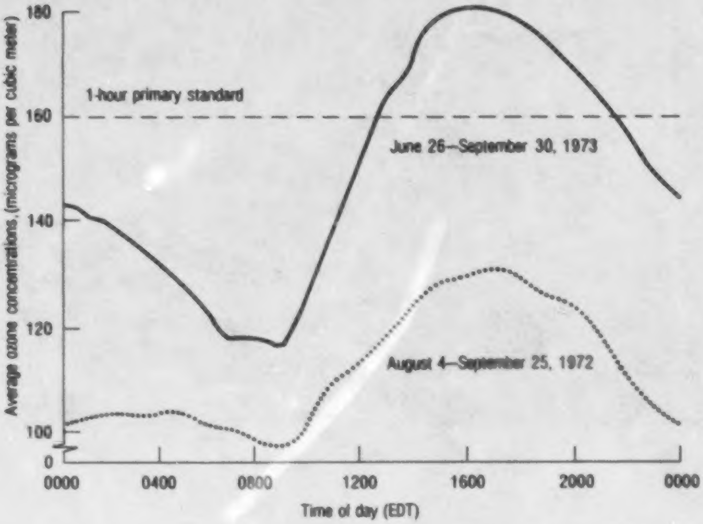
Station No.	Town	County	State
1	McHenry	Garrett	Md.
2	Kane	McKean	Pa.
3	Coshocton	Coshocton	Ohio
4	Lewisburg	Greenbrier	W. Va.



Source: Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1973* (Washington, D.C.: Government Printing Office, 1974), Figure 5-10.

Figure 11

Average Ozone Levels at Rural Site in McHenry, Maryland



Source: Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1973* (Washington, D.C.: Government Printing Office, 1974), Figure 5-10.

In many cases, oxidants or their precursors travel from urban areas. The atmospheric formation, transport, and dynamics of oxidants are extremely complex, however, and definitive answers about all rural oxidant problems will not come easily. Less than one-half the man-made emissions of oxidant precursors are produced by motor vehicles (Figure 1). EPA is assessing oxidant control strategies to emphasize control of nonautomotive sources.

Oxidant or ozone levels in 79 regions exceed the ambient standards scheduled for attainment by May 31, 1975, as shown in Table 7.

Nitrogen Oxides and Hydrocarbons Very little monitoring is done for nitrogen oxides and hydrocarbons. Most of the interest centers on their role in the formation of photochemical oxidants. In addition, because of the difficulties in establishing an approved federal reference method for measuring nitrogen dioxide, no nationwide trends can be discussed. If one considers the candidates for reference methods, however, 54 stations reported a year's data that satisfied monitoring criteria for 1973; 9 reported nitrogen dioxide levels above the primary annual standard (Figure 4). In experimental monitoring at 200 sites, most areas appeared to meet the ambient standard, but 16 cities appeared to exceed the standard. They are listed in Table 8.

Table 7

Air Quality Control Regions Exceeding National Standards for Oxidants/Ozone in 1973 and/or 1974

Air quality control region	Principal urban area reporting violations	Air quality control region	Principal urban area reporting violations
004	Birmingham, Alabama	119	Boston, Massachusetts (TCP)[2]
005	Mobile, Alabama	120	Providence, Rhode Island (TCP)[1]
013	Las Vegas, Nevada	121	Nashua, New Hampshire
015	Phoenix, Arizona (TCP)[1]	123	Detroit, Michigan
018	Memphis, Tennessee	124	Toledo, Ohio
024	Los Angeles, California (TCP)[2]	131	Minneapolis, Minnesota (TCP)[1]
025	Salinas, California	151	Scranton, Pennsylvania
028	Sacramento, California (TCP)[2]	152	Albuquerque, New Mexico
029	San Diego, California (TCP)[2]	153	Dona Ana County, New Mexico
030	San Francisco, California (TCP)[2]	158	Utica, New York
031	Fresno, California (TCP)[2]	159	Glen Falls, New York
032	San Luis Obispo, California	160	Rochester, New York (TCP)[2]
033	Lancaster, California	161	Schenectady, New York
036	Denver, Colorado (TCP)[1]	162	Buffalo, New York
043	New York City, New York (TCP)[2]	167	Charlotte, North Carolina
045	Philadelphia, Pennsylvania (TCP)[2]	171	Asheville, North Carolina
047	Washington, D.C. (TCP)[2]	173	Dayton, Ohio
050	Miami, Florida	174	Akron, Ohio
051	Naples, Florida	176	Columbus, Ohio
056	Atlanta, Georgia	178	Youngstown, Ohio
060	Honolulu, Hawaii	184	Oklahoma City, Oklahoma
067	Chicago Illinois (TCP)[1]	186	Tulsa, Oklahoma
070	St. Louis, Missouri	193	Vancouver, Washington (TCP)[2]
072	Paducah, Kentucky	195	Johnstown, Pennsylvania
075	Springfield, Illinois	196	Harrisburg, Pennsylvania
077	Owensboro, Kentucky	197	Baden, Pennsylvania (TCP)[2]
078	Louisville, Kentucky	200	Richland County, South Carolina
079	Newport, Kentucky	207	Kingsport, Tennessee
080	Indianapolis, Indiana (TCP)[2]	208	Nashville, Tennessee
085	Omaha, Nebraska	212	Austin, Texas (TCP)[3]
092	Des Moines, Iowa	214	Corpus Christi, Texas (TCP)[3]
095	Topeka, Kansas	215	Dallas, Texas (TCP)[3]
099	Wichita, Kansas	216	Houston, Texas (TCP)[3]
103	Ashland, Kentucky	217	San Antonio, Texas (TCP)[3]
106	New Orleans, Louisiana	220	Salt Lake City, Utah (TCP)[1]
107	Berlin, New Hampshire	223	Norfolk, Virginia
115	Baltimore, Maryland (TCP)[2]	225	Richmond, Virginia
117	Pittsfield, Maine	229	Seattle, Washington (TCP)[1]
118	Worchester, Massachusetts	239	Milwaukee, Wisconsin
		240	Columbia County, Wisconsin

[1] Transportation Control Plan designed for carbon monoxide only.

[2] Transportation Control Plan designed for both carbon monoxide and photochemical oxidants.

[3] Transportation Control Plan designed for photochemical oxidants only.

Source: Environmental Protection Agency.

Table 8

Air Quality Control Regions with Ambient Nitrogen Dioxide Concentrations at or above National Standards

Air quality control region	Principal urban area reporting violations	Air quality control region	Principal urban area reporting violations
015	Phoenix, Arizona	056	Atlanta, Georgia
024	Los Angeles, California	067	Chicago, Illinois
029	San Diego, California	115	Baltimore, Maryland
030	San Francisco, California	119	Boston, Massachusetts
036	Denver, Colorado	123	Detroit, Michigan
042	Springfield, Massachusetts	174	Canton, Ohio
043	New York, New York	220	Salt Lake City, Utah
045	Philadelphia, Pennsylvania	225	Richmond, Virginia

Source: Environmental Protection Agency.

"NONCRITERIA" POLLUTANTS

The vast majority of air quality measurements made in recent years has been aimed at determining the ambient concentrations of four air pollutants—total particulate matter, sulfur dioxide, carbon monoxide, and oxidants. The selection of these particular pollutants for extensive measurement resulted from:

- The evolving state of scientific knowledge about air pollution effects on health, vegetation, and materials
- Federal, state, or local monitoring requirements
- Availability of acceptable methods and equipment for sampling and analysis
- The technological history and traditions of air quality monitoring.

It is becoming increasingly evident that the air pollutants upon which our standards and monitoring have been focusing do not represent all the important parameters of air quality. In some cases, they may not even represent the most important or informative ones.

Present ambient air quality standards and most monitoring of suspended particulates, for example, are concerned only with the total weight of airborne particulate matter, as measured by high-volume samplers. But total weight is at best only a crude indicator of trends in the kinds of particulates that are most important to human health. By itself such a measurement is inadequate for many scientific purposes and therefore may be inadequate as a regulatory guide.

There are two major reasons for this inadequacy. First, the total weight of airborne particulates does not distinguish between tiny particles, which can penetrate the human respiratory system efficiently and thus pose considerable hazard to health, and the larger particles which generally do not. The proportion of respirable (small) particles—less than 3 microns in diameter—varies roughly from less than one-third to more than two-thirds of the total suspended particulates.

The second important reason is that most of the public health effects of particles in the air depend upon their chemical composition, which can also vary greatly. Toxic substances like acid sulfates, nitrates, trace metals, and organic compounds are important and potentially harmful constituents of airborne particulate matter, but there are no ambient standards and there is very little monitoring for these constituents now. They are described in Table 9.

Particulate Sulfates

Suspended sulfate aerosols are believed among the air pollutants most damaging to human health; some of their estimated effects are listed in Table 10. A relatively small proportion of the sulfates in air was directly emitted as particulates, however. Most sulfates are formed through secondary chemical reactions in the atmosphere from other kinds of sulfur compounds which originate from both natural and manmade sources.

On a worldwide scale, most of the airborne sulfur compounds are believed to originate from natural sources such as volcanic activity, ocean salts, and decomposition of dead plants and animals. In an industrialized nation like the United States, however, manmade sulfur emissions—mostly in gaseous form—are believed to outweigh emissions from natural sources.[14]

At least 95 percent of all manmade sulfur emissions is in the form of sulfur dioxide. The remainder is emitted as hydrogen sulfide or sulfur trioxide and a small amount of particulate sulfates. Once in the air, these sulfur compounds can be converted to sulfates by a variety of chemical reactions; the mechanisms are shown in Table 11.

The best available data on ambient levels of sulfates and other noncriteria air pollutants are those of EPA's National Air Surveillance Network. This federal network consists of about 250 monitoring sites generally located in urban areas. As shown in Figure 12, as of 1970, the particulate sulfate levels observed at 164 urban NASN sites were highest in the Northeast. Findings were similar at 25 nonurban sites, but urban sulfate concentrations were substantially higher than nonurban. Only in rural areas of the Western states were sulfate levels near the average global background range of 1-2 micrograms per cubic meter.

The NASN data also show that since the late 1950's, particulate sulfate levels have remained fairly constant in spite of the reductions observed in sulfur dioxide levels over that period (Figure 13).

It is not yet entirely clear why particulate sulfate levels have not declined when sulfur dioxide levels have. This paradox has been attributed to complex phenomena involving long-distance transport of airborne sulfur compounds and to atmospheric chemistry, but the

Table 9

Other Important Air Pollutants[1]

Pollutant	Characteristics	Principal sources	Principal effects[2]	Controls
Sulfates (SO_4)	Aerosol formed by sulfur oxides; in moist environment appears as sulfuric acid (H_2SO_4) mist or rain	Atmospheric reactions of sulfur oxide precursors	Health: Aggravation of respiratory diseases including asthma, chronic bronchitis, and emphysema; reduced lung function: irritation of eyes and respiratory tract; increased mortality Other: Corrosion of metals, deterioration of electrical contacts, paper, textiles, leather, finishes and coatings, and building stone; formation of acid rain; leaf injury and reduced growth in plants	Reduction of sulfur oxide and oxidizing agent emissions
Nitrates (NO_3)	Aerosol formed by nitrogen oxides; in moist environment appears as nitric acid (HNO_3) mist or rain	Atmospheric reactions of nitrogen oxide precursors	Health: Aggravation of respiratory and cardiovascular illnesses and chronic nephritis Other: Fading of paints and dyes, impairment of visibility, reduced growth and premature leaf drop in plants	Reduction of nitrogen oxides

Asbestos	Naturally occurring fibrous silicates; used for thermal insulation, floor tiles, and brake lining; occurs as fine particulate	Asbestos mining and processing, spraying of fire proofing insulation, attrition of brake linings	Health: Fibrosis, calcification, and cancer of the lungs and pleural cavity Other: Unknown	Containment of asbestos processing and handling operations; cleaning of residual gases by particulate control techniques; cleaning of residual gases by condensation, filtration through impregnated charcoal, or scrubbing with water
Arsenic (As)	A volatile, highly toxic element; occurs as arsenic oxide, aerosol or dust	Smelting of gold and copper ores, combustion of coal, cotton ginning and burning of cotton trash, dispersion of pesticides	Health: Bronchitis and other respiratory illnesses; dermatitis; skin cancer Other: Unknown	
Beryllium (Be)	A hard metal; occurs as beryllium oxide aerosol or dust	Mining, smelting, and machining beryllium; combustion of coal	Health: Suspected cause of general systemic disease with pulmonary damage, suspected cause of bone and lung cancer Other: Unknown	Cleaning of residual gases by particulate control techniques
Cadmium (Cd)	A heavy metal; occurs as cadmium oxide aerosol or dust	Mining and smelting of lead, copper, and zinc; manufacturing of batteries, alloys paints, plastics	Health: Accumulates in body organs, possible nervous system impairment, suspected adverse cardiovascular effects Other: Unknown	Cleaning of residual gases by particulate control techniques
Chromium (Cr)	A hard metal highly resistant to corrosion, occurs as aerosol or dust	Electroplating processes, manufacture of stainless steel, combustion of coal and refuse	Health: Cancer of the respiratory system, dermatitis, skin ulcers Other: Discoloration of paints	Cleaning of residual gases by particulate control techniques

See footnotes at end of table.

Table 9—Continued

Other Important Air Pollutants [1]

Pollutant	Characteristics	Principal sources	Principal effects [2]	Controls
Lead (Pb)	A heavy metal; occurs as lead oxide aerosol or dust	Automotive emissions, lead smelting and processing, manufacture of lead products, combustion of coal and refuse, dispersion of lead-containing pesticides	Health: Accumulates in body organs; impairment of nervous system, bones, and kidneys Other: Unknown	Cleaning of residual gases by particulate control techniques; replacement of lead additives in gasoline
Mercury (Hg)	A heavy metal that is liquid at normal temperatures; occurs as vapor or aerosol	Mining and refining of mercury, manufacture of chlorine and caustic soda, combustion of fossil fuels and refuse, dispersion of mercury pesticides	Health: Accumulates in body organs, inhibition of enzymes; impairment of nervous system; fetal malformations Other: Toxic to birds of prey and other wildlife, leaf injury and reduced growth in plants	Cleaning of residual gases by by condensation, filtration through impregnated charcoal, or scrubbing with water
Chlorine (Cl_2)	A dense, greenish-yellow gas with an irritating odor; strong oxidizing agent	Preparation, processing, and liquefaction of chlorine; chemical and pulp and paper processes	Health: Pulmonary edema, pneumonitis, bronchitis Other: Corrosion of metals, leaf injury	Cleaning of residual gases with liquid scrubbers or solid absorbents, such as silica gel
Fluorides	Gaseous and solid compounds of fluorine	Industrial processes (e.g., production of phosphate fertilizer, aluminum metal, brick, and tile), combustion of coal	Health: Irritation of respiratory tract and other sensitive tissues, enzyme inhibition Other: Corrosion of metals, leaf injury, reduced plant growth	Cleaning of residual gases by particulate control techniques, particularly wet scrubbing

Sulfides and mercaptans	Gaseous sulfur compounds with unpleasant odor perceptible at very low concentrations	Processing of petroleum, coking of coal, paper pulping processes, inadequately treated sewage and solid waste	Health: Discomfort, nausea, headache, loss of appetite, allergic reactions Other: Tarnishing of silver and copper, deterioration of lead-based paint, impaired aesthetic enjoyment, leaf injury and reduced growth in plants	Recovery and conversion to sulfur, filtration of air through activated carbon, masking with pleasant odors, adequate containment and treatment of sewage
Other odorants (e.g., ammonia, amines and amides, phenols, solvents)	Gaseous substances with offensive odors	Chemical processes, animal rendering and food processing, inadequately treated sewage	Health: Discomfort, nausea, headache, loss of appetite, allergic reactions Other: Impaired aesthetic enjoyment	Removal or destruction of odorants by oxidation and absorption, filtration of air through activated carbon, masking with more pleasant odors, containment of fuel and solvent tanks, adequate containment and treatment of sewage
Radioactive substances (e.g., Co-60, I-137, Sr-90)	Gaseous, liquid, or solid substances that give off high-energy radiation	Natural sources (rocks, soils, and cosmic rays); nuclear weapons testing; nuclear power generation; uranium mining, refining, and machining operations	Health: Leukemia, bone cancer, genetic damage Other: Degradation of plastics and other materials, leaf injury, reduced plant growth	Containment of nuclear weapons tests, remote siting of nuclear operations, wet mining of uranium, containment of uranium processing, cleaning of residual gases by particulate control techniques and by absorption or chemisorption

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[1] Does not include the major pollutants for which national ambient air quality standards have been established.

[2] Known or suspected.

Source: Based on information compiled by Enviro Control, Inc.

Table 10

Estimates of Adverse Health Effects of Aerosol Acid Sulfates

Effect	Threshold concentration (micrograms per cubic meter)	Duration of exposure
Increased daily mortality (four studies)	25	24 hours or longer
Aggravation of heart and lung disease in elderly (two studies)	25	24 hours or longer
Aggravation of asthma (four studies)	6–10	24 hours or longer
Increased acute respiratory diseases in children (four studies)	13	Several years
Increased risk of chronic bronchitis		
Cigarette smokers	15	Up to 10 years
Nonsmokers	10	Up to 10 years

Source: J. F. Finklea, et al., "Health Effects of Increasing Sulfur Oxides Emissions," Environmental Protection Agency (draft, 1975).

Table 11

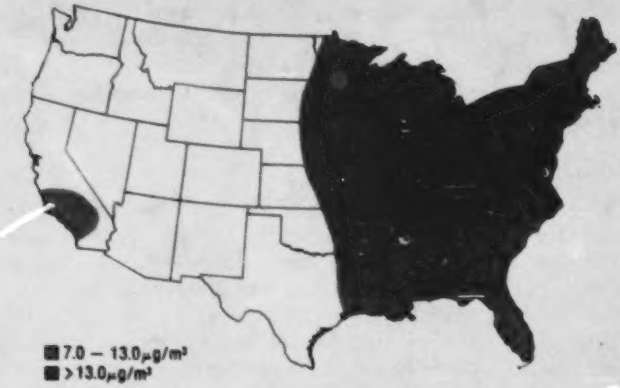
Mechanisms That Convert Sulfur Dioxide to Sulfates or Sulfuric Acid Aerosols

Mechanism	Overall reaction	Factors on which sulfate formation primarily depends (in addition to sulfur dioxide concentration)
Direct photooxidation	$SO_2 \xrightarrow[\text{water}]{\text{light, oxygen}} H_2SO_4$	Sunlight intensity
Indirect photooxidation	$SO_2 \xrightarrow[\text{organic oxidants, OH}]{\text{smog, water, } NO_x} H_2SO_4$	Organic oxidant concentration, OH, NO_x
Air oxidation in liquid droplets	$SO_2 \xrightarrow{\text{liquid water}} H_2SO_3$ $NH_3 + H_2SO_3 \xrightarrow{\text{oxygen}} NH_4^{+} + SO_4^{=}$	Ammonia concentration
Catalyzed oxidation in liquid droplets	$SO_2 \xrightarrow[\text{heavy metal ions}]{\text{oxygen, liquid water}} SO_4^{=}$	Concentration of heavy metal (Fe, Mn) ions
Catalyzed oxidation on dry particles	$SO_2 \xrightarrow[\text{carbon, water}]{\text{oxygen, particulate}} H_2SO_4$	Carbon particle concentration (surface area)

Source: Environmental Protection Agency.

Figure 12

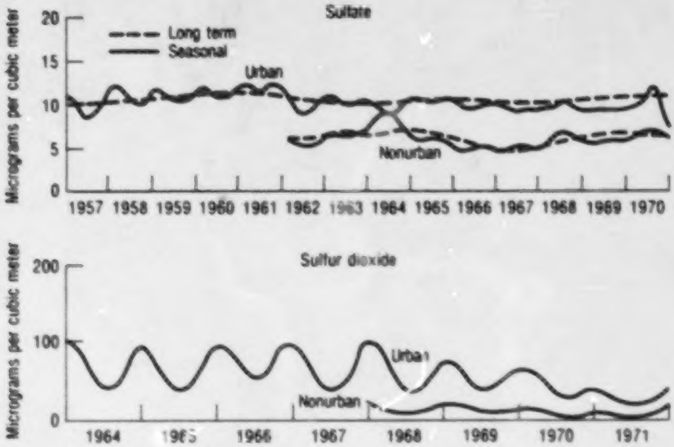
Urban Sulfate Concentrations, 1970



Source: J.F. Finklea et al., "Health Effects of Increasing Sulfur Oxides Emissions," draft (Environmental Protection Agency, March 1975), Figure 3.

Figure 13

National Air Sampling Network (NASN) Sulfate and Sulfur Dioxide Levels, 1957-71



Source: Environmental Protection Agency.

process is still poorly understood. Yet it is worth noting that the relatively stable sulfate levels have corresponded more closely to nationwide sulfur dioxide emissions, which have not declined much in recent years, than to ambient sulfur dioxide levels in urban air, which have. This similarity may be related in part to the many powerplants and other sources in outlying areas.[18] The nationwide geographic pattern in sulfate levels (Figure 12) corresponds roughly with the geographic distribution of sulfur dioxide emissions and powerplant sites, shown in Figure 14.

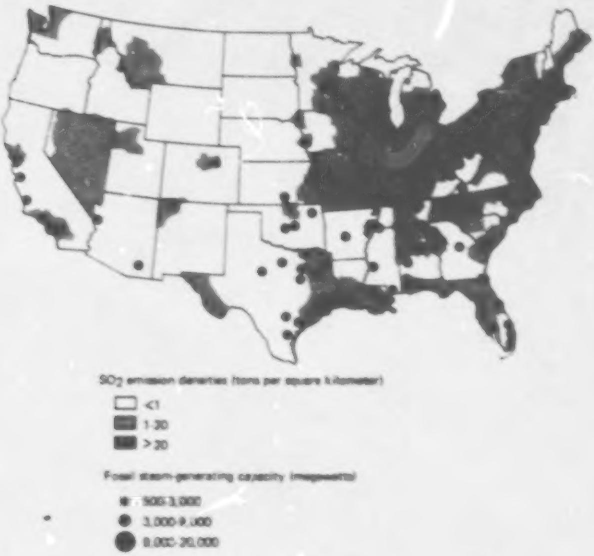
Particulate Organics

Organic particles in the air are another constituent of total suspended particulates for which specific ambient standards have not been established. In contrast to sulfates, however, the organic particulate levels in urban areas have been observed to decline in recent years and thus have not been considered as urgent a problem.

Organic particulates are that portion of the total suspended particulate matter which is soluble in benzene. These benzene-soluble

Figure 14

Fossil Steam-Generating Capacity and Sulfur Dioxide Emissions, 1970


SO_2 emission densities (tons per square kilometer)
<1
1-20
>20
Fossil steam-generating capacity (megawatts)
500-3,000
3,000-8,000
8,000-20,000

Source: J.F. Finklea et al., "Health Effects of Increasing Sulfur Oxides Emissions" (Environmental Protection Agency, draft, 1974); Environmental Protection Agency, "Alternative Control Strategies for Sulfates" (draft, 1974).

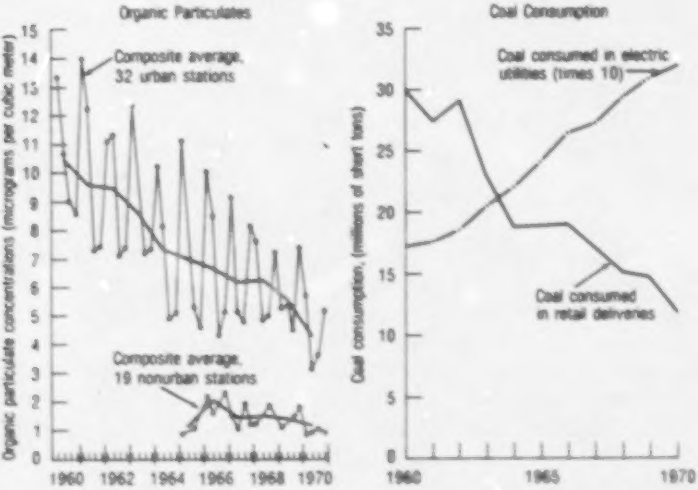
organics include such substances as benzo(a)pyrene, a polycyclic hydrocarbon that has been identified as a potential carcinogen.[16] The major sources of benzene-soluble organics—which can comprise over 10 percent of the total suspended particulate matter in the air of some cities—are the burning of coal, wood, and refuse, coke production, and motor vehicle emissions.

Based on trends reported from 32 urban monitoring stations of EPA's National Air Surveillance Network, the average levels of organic particulates dropped about 55 percent between 1960 and 1970, as Figure 15 indicates. Improving trends were observed over this period at 27 of the 32 sites, including Atlanta, Baltimore, Chicago, Cleveland, Houston, Los Angeles, Philadelphia, San Francisco, and Seattle. Only in Helena, Montana, was a significant increase in organic particulate levels observed. In a more extensive survey of 126 monitoring sites, 118 showed decreasing levels of organic particles.

This improvement has apparently resulted from the reduced use of coal for residental space heating as well as from better control of open burning in dumps and coal refuse piles. In general, coal combustion is less efficient and produces more organic emissions per ton in residential furnaces than it does in electric powerplants. As shown in the figure, a distinct seasonal variability was observed in urban levels of

Figure 15

Average Organic Particulate Levels and Coal Consumption, 1960-70



*Source: Environmental Protection Agency, Monitoring and Air Quality Trends Report, 1973 (Washington, D.C.: Government Printing Office, 1974); organic particulates trends based on data from the National Air Surveillance Network, Figures 4-8 and 4-13.

organic particulates, with the highest levels measured each year during the heating season. Moreover, the observed drop in ambient organic levels has correlated closely with the decreasing residential use of coal rather than with the increasing trend in coal use by electric utilities; Figure 15 shows the comparison.

THE QUALITY OF MONITORING

Ambient monitoring must provide a great deal of the information that is needed to guide the nation's efforts to improve air quality. Air pollution abatement in the United States today is an undertaking of staggering proportion. To conduct it effectively and efficiently, we must be well informed about air quality conditions and trends. By far, the most critical need for improving that information is better quality control in the processes by which air monitoring data are acquired and handled. This means that:

- The right pollutants must be measured
- The numbers, locations, and methods of measurement must be scientifically consistent and adequate to provide valid and useful data
- The data must be handled and used effectively to provide the needed information.

Most of the air monitoring data in EPA's National Aerometric Data Bank are provided by state and local networks; they are discussed in an earlier section. In past years, many of these data are known to have been obtained by unapproved or unacceptable methods of analytical measurement. EPA's inventory of the 1973 data provided by the states showed that for sulfur dioxide, 23 percent of all stations used an unapproved method of measurement; for nitrogen dioxide, 61 percent of all stations used a method which has been designated unacceptable by EPA (the remaining 39 percent used unapproved methods because there has been no approved NO_x method); and for oxidants, 70 percent of all stations used either an unapproved or an unacceptable method.[17]

Some of EPA's regional offices have made an effort to evaluate the extent and severity of quality assurance deficiencies in the air monitoring operations performed by state and local agencies. In 1973–74, for example, the Surveillance and Analysis Division of EPA's Region V (Chicago) office conducted onsite evaluations at 56 of the 228 air monitoring sites operated by Illinois and Michigan and by Chicago, Cincinnati, and Cleveland. Although their monitoring activities were judged commendable in some respects, serious deficiencies were found. The most commonly encountered deficiencies were:

- Unacceptable analytical methods for SO_2, NO_2, and O_x
- Improper location of monitoring sites
- Improper placement of instruments

- Inadequate or improper calibration of instruments
- Inadequate or improper maintenance of instruments
- Improper reference standards and materials
- Unqualified or inadequately trained operators
- Errors in data handling and calculation
- Questionable laboratory support facilities
- Inadequate planning for quality assurance or for the monitoring program itself.[10]

Because of the deficiencies, data from these sites must be interpreted cautiously.

Many of the state and local data stored in EPA's National Aerometric Data Bank are not used to develop control strategies. However, given the limitations in existing resources for monitoring, much more progress is needed in the area of quality assurance so that the data are in fact a representative and valid basis for control action decisions. Although the air quality conditions and trends discussed on the preceding pages basically seem valid and significant—as corroborated by controlled measurements made by federal and research personnel—the fact remains that many of our air quality data are only crude indicators of ambient conditions.

During the past few years, EPA's efforts to upgrade state and local monitoring data have effected some substantial improvements on a limited scale. For example, EPA developed standardized measurement methods, distributed standard analytical reference materials, promulgated procedures and guidelines for monitoring methods, evaluated ongoing monitoring activities across the nation, and provided training and technical assistance to state and local agencies. In addition, according to EPA, stations using unacceptable methods are converting to acceptable methods; states must perform quality assurance tests on the data that they submit; state and local agencies are subject to periodic EPA evaluation and performance surveys; and EPA plans to publish quality assurance guidelines.

Progress is being made but the resources devoted to quality assurance have been very limited and obviously are not sufficient in light of the findings listed above. In the next few years, a higher priority will need to be placed on programs to improve state and local air monitoring activities. It will be necessary to develop better guidelines for more standardized siting of monitoring stations, to increase the frequency of federal onsite evaluations, and to extend technical assistance at field locations throughout the United States.

INTERPRETING AND REPORTING AIR QUALITY

A description of the nation's air quality should provide an understandable and scientifically accurate picture of the significance of air pollution levels to health, property, vegetation, and natural ecosystems. In addition, many people want to know how their local air quality changes from day to day.

Air Quality Indices

Air quality in our cities is reported daily to millions of Americans through television, radio, and newspapers. More often than not, the information is provided in some form of air quality index.

Typically, the index is a single number or a set of numbers that is derived from measured levels of air pollutants. The index attempts to summarize and simplify the presentation of many data. In addition, air quality indices have been developed to summarize long-term trends and evaluate air pollution abatement policies (Table 12). But because of the lack of information about the many indices being used daily throughout the country, CEQ and EPA examined those in the 55 largest cities.[19]

Except in 2 cities, all the indices in the 33 largest cities that use indices are different (4 states have adopted their own index formats). Fifteen basically different types were identified.

How different these indices are may be seen by looking at a hypothetical index value of "25," whose meaning may range from unhealthy to fair to excellent, depending on where it is reported (Table 13). Sometimes an index value is accompanied by a descriptor word; in other cases it is not. Some indices incorporate data on all the pollutants for which national ambient air quality standards have been designated, and other indices report on only some of them or else use altogether different variables. The mathematical techniques used to calculate these indices also vary considerably.

The many differences are confusing. They raise questions about the scientific validity of the indices and limit their usefulness for comparing urban areas and for obtaining national indicators. Moreover, many local pollution control personnel have suggested that a standard index would be welcome. For these reasons CEQ established an interagency task force to develop a standard air quality public-reporting index that could be recommended for nationwide use. The task force will complete its work early in 1976.

Air Pollution Damage Curves

There is little doubt that relationships exist between pollution levels and increased mortality and disease rates, diminished enjoyment of the outdoors, lower crop yields, more frequent maintenance and replacement of exposed materials, and other losses. By reducing pollution levels, we can decrease the damages and enjoy the benefits. CEQ and EPA are sponsoring a study to assess present scientific capabilities to characterize the quantitative relationships that exist between ambient air pollution levels and the damages that they cause.[20]

Legislators, planning officials, and others are often faced with weighing the effects of pollution levels against direct costs and their socioeconomic effects. Reaching decisions has grown more difficult as the costs of controlling pollution have been felt more acutely and are easier to quantify than the benefits.

A benefit-cost analysis is typically inexact because many of the benefits are social, are diffuse, and are not easily expressed in dollars. However, the process of logical and systematic scrutiny inherent in such an analysis can contribute substantially to informed decisions.

The physical and biological damages from pollutants may be estimated and weighed against the cost of controls. The economic damages of air pollution may also be determined directly as a function of ambient pollution levels through surveys of property values, declared willingness to pay, legislative decisions, and awards by the courts.

One way to present such choices is through damage function analysis. A damage function is the quantitative expression of a relationship between exposure to specific pollutants and the type and extent of the resulting damage to a target population. If an effect is physical or biological, the relationship is termed a physical or biological damage function or a dose-effect function.

In reporting a damage function, one needs to specify the pollutant, the dose rate, the effect, and the target population (the "population at risk"). The dose rate is the rate at which ambient concentrations vary with time. Specifying the population at risk involves characterization of the nature and size of the exposed population. It allows the definition of the total damages of a given exposure level by multiplying the corresponding unit damage (e.g., increased mortality) for the specified population at risk (e.g., white males over 65) by the number of units within this population, and it permits correction of results to reflect population variables (e.g., age, sex, occupation).

A typical S-shaped damage function is presented in Figure 16. It shows the damage that results from a given exposure to a specific air pollutant. The vertical axis may represent the number of individuals affected or the severity of effect for the whole population. The horizontal axis indicates dosage in terms of time, concentration, or concentration for a fixed period of time. The lower portion of the curve suggests that up to a certain exposure value, known as a threshold level, there is no observed damage for specific acute effects and target populations. The upper portion of the curve indicates that there exists a damage saturation level, such as death of the target population or total destruction of a crop, beyond which increased exposure levels cannot produce additional damage. The middle, quasi-linear portion is very useful in that any data points here may be readily interpolated, and the frequent assumption about linearity of a damage function is most valid in this sector.

The data required to develop physical or biological damage functions are obtained primarily through epidemiological, field, clinical, toxicological, and laboratory investigations. In the area of human health effects, for example, most damage functions are developed

Table 12

Summary of Air Pollution Indices Appearing in the Technical Literature

Name	Variables	Equation	Range	Categories	Description
Green's Combined Index (CI)[1]	SO_2, COH	$CI=0.5\,(84.0\,SO_2^{0.431}+26.6\,COH^{0.576})$	0–100+	0–49 Desired level, clean, safe air 50–59 First alert, intermediate 60–69 Second alert 68+ Third alert 100+ Extreme level	Index is based on proposed and adopted air quality standards; SO_2 concentrations for each category differ by a factor of 5.0; COH values differ by a factor of 3.33. Index is applicable only during colder seasons when SO_2 concentrations are elevated.
Ontario Air Pollution Index (API)[1]	SO_2, COH	$API=0.2\,(30.5\,COH+126.0\,SO_2)^{1.35}$	0–580+	0–31 Acceptable 32–49 Advisory level 50–74 First alert 75–99 Second alert 100+ Episode threshold level	The coefficients and exponent relate API values to pollution levels attained during past air pollution episodes.
PINDEX[1]	CO, SO_x, TSP, NO_x, OX, HC	$PINDEX=\frac{TSP}{375}+\frac{SO_x}{1430}+\frac{NO_x}{514}+\frac{CO}{40000}+\frac{HC}{19300}+\frac{OX}{214}+SYN$ where SYN = PM·SO_x synergistic term	0–100+	NA	Actual pollutant concentrations are divided by their respective tolerance factor (one-hour equivalent standard) which is based on the California or other appropriate standards. The OX value includes that estimated from $NO_x + HC + h\nu = OX$. The SYN term is the smallest of the PM or SO_x terms.

Oak Ridge Air Quality Index (ORAQI)[4]	CO, SO_2, TSP, NO_2, OX	$ORAQI=\left[5.7\sum_i (C_i/S_i)\right]^{1.37}$ C_i=conc. pollutant i S_i=standard for pollutant i	0–1000	<20 Excellent 20–39 Good 40–59 Fair 60–79 Poor 80–99 Bad 100+ Dangerous	Index may be calculated for any combination of from $i=1$ to 5 pollutants using nomograph; pollutant standards, S_i, are 24 hr. extrapolations of secondary NAAQS. When pollutant concentrations are at background levels, ORAQI=10; when all concentrations are at standards, ORAQI=100.
Mitre Air Quality Index (MAQI)[5]	CO, SO_2, TSP, NO_2, OX	$MAQI=\sqrt{\sum_i I_i^2}$ I_i=indictor for each pollutant i	0–3+	MAQI<1: no std, exceeded 1<MAQI <3: stds met or exceeded MAQI >3: one or more std exceeded	Index may be calculated for any combination of $i=1$ to 5 pollutants; indicator, I_i, is based on secondary NAAQS: $I_i=\sqrt{\left(\frac{C_{ia}}{S_{ia}}\right)^2+\delta\sum_i\left(\frac{C_{ih}}{S_{ih}}\right)^2}$ where: C_{ia} =mean concentration of pollutant i, during longest measurement period a, as specified by standard S_{ia}. C_{ih} =mean concentration of pollutant i, during hourly measurement period h, as specified by standard S_{ih}. $\delta=1$ if $C_{ih}>S_{ih}$ $\delta=0$ if $C_{ih}<S_{ih}$

See footnotes at end of table.

Table 12—Continued

Summary of Air Pollution Indices Appearing in the Technical Literature

Name	Variables	Equation	Range	Categories	Description
Extreme Value Index (EVI)[8]	CO, SO_2, TSP, OX	$EVI=\sqrt{\sum_i E_i^2}$ E_i=indicator for each pollutant i	0, >1	EVI=0: all stds being met EVI>1: at least one std exceeded	Index may be calculated for any combination of $i=1$ to 4 pollutants; E_i is based on those secondary NAAQS not to be exceeded more than once per year, e.g., the hourly standards and is given by: $E_i=\sqrt{\sum_h \left(\frac{A_{ih}}{S_{ih}}\right)^2}$; $A_{ih}=\sum_j \delta_j (C_{ih})_j$ where: A_{ih}=summation of those values, C_{ih}, which exceed the hourly measurement period h, for pollutant, i, as specified by standard S_{ih}. $\delta_j=1$ if $(C_{ih})_j>S_{ih}$ $\delta_j=0$ if $(C_{ih})_j<S_{ih}$
Combustion Products Index (CPI)[8]	NA	$CPI=\frac{\text{fuel burned}}{\text{ventilating volume}}$	NA	NA	The fuel burned (tons) is obtained by inventorying fuel deliveries; ventilating volume (volume of air into which the fuel combustion products are mixed) is the product of the inventory area, mixing depth, and wind speed.

Air Quality Index (AQI) [7]	CO, SO_2, TSP, NO_x, OX	$AQI = \sum_i W_i PI_i$	NA	NA	
		W_i – weighting factor for pollutant severity PI_i – standardized pollutant index	NA	NA	The AQI may be calculated for any combination of from $i = 1$ to 5 pollutants whose concentrations are predicted by a simple diffusion model using emission inventory data; the predicted concentrations are then standardized to give the standardized pollutant index, PI_i: $PI_i = \overline{Y} + \frac{S(X_i - \overline{X}_i)}{s_i}$ where: $\overline{Y}$ – preset mean S – preset standard deviation X_i – predicted pollutant concentration $\overline{X}_i$ – mean predicted pollutant concentration s_i – standard deviation of predicted pollutant concentrations

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[1] M. H. Green, "An Air Pollution Index Based on Sulfur Dioxide and Smoke Shade," *Journal of the Air Pollution Control Association*, 11 (1966), p. 703

[2] L. Shenfeld, "Note on Ontario's Air Pollution Index and Alert System," *Journal of the Air Pollution Control Association*, 20 (1970), p 612.

[3] L. R. Babcock, Jr., "A Combined Pollution Index for Measurement of Total Air Pollution," *Journal of the Air Pollution Control Association*, 20 (1970), p. 653.

[4] W. A. Thomas, L. R. Babcock, Jr., and W. D. Shults, "Oak Ridge Air Quality Index," ORNL–NSF–EP–8 (Oak Ridge, Tennessee: Oak Ridge National Laboratory, 1971).

[5] The Mitre Corporation, "The National Environmental Indices: Air Quality and Outdoor Recreation," MTR–6159 (McLean, Virginia, 1972).

[6] T. A. Rich, "Air Pollution Studies Aided by Overall Air Pollution Index," *Environmental Science and Technology*, 1 (1967), p. 796.

[7] T. L. Miller, "Short Time Averaging Relationships to Air Quality Standards (STARAQS)—A Predictive Air Quality Index Model for Use by Air Pollution Control Agencies," presented at the 66th annual meeting of the Air Pollution Control Association, June 1973.

Source: Gary C. Thom and Wayne R. Ott, "Air Pollution Indices: A Compendium and Assessment of Indices Used in the United States and Canada," Council on Environmental Quality and Environmental Protection Agency (draft, June 1975).

Table 13

How 13 Cities Interpret an Index Value of 25

City	Air pollution descriptor
Tampa, Florida	Moderate
Denver, Colorado	Fair
Washington, D.C.	Fair
Baltimore, Maryland	Fair
Cincinnati, Ohio	Excellent
Miami, Florida	Normal
Louisville, Kentucky	Good
Los Angeles, California	Stage 1
San Francisco, California	Severe
St. Paul, Minnesota	Unhealthy
Trenton, New Jersey	Unsatisfactory
Albany, New York	High
New York, New York	Unhealthy

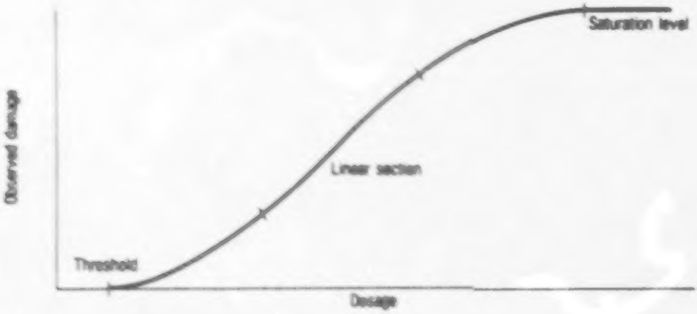
Source: Gary C. Thom and Wayne R. Ott, "Air Pollution Indices: A Compendium and Assessment of Indices Used in the United States and Canada," Council on Environmental Quality and Environmental Protection Agency (draft, June 1975).

on the basis of epidemiological studies, which require substantial effort to identify a degree of damage corresponding to a given exposure to one pollutant over a specified period. The results may represent only one point in the construction of a damage function for that pollutant, dose rate, and target population. It takes many such points to construct a curve that is reliable.

The following discussion of the effects of sulfur dioxide on human health and mortality is presented to demonstrate an example of a damage function. SO_2 was one of the first pollutants to be implicated in human disease and death. More recently there have been indications that it is a proxy for a more damaging agent—suspended sulfates (the sulfate fraction of particulates) and/or other agents.

Figure 16

Typical Damage Function



A composite plot of the relationship between daily sulfur dioxide levels and percentage change from the mean of daily mortality rate, based on the results of two New York City studies, is shown in Figure 17. The data appear to fall on the linear portion of the curve, and it is not clear whether a threshold level exists. Mortality rate changes appear both below and above the mean death rate, depending on variations of SO_2 levels with respect to the value assumed in establishing the mean death rate.

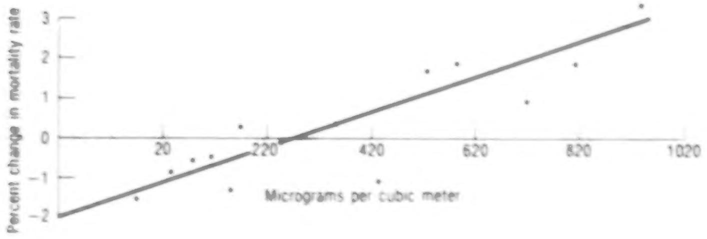
It is easy to find deficiencies in Figure 17. For one, it attempts to correlate daily values of death rate and sulfur dioxide levels without accounting for other factors which may affect death rates or for any time lag between levels of high pollution and subsequent deaths. It relates nothing about days of discomfort, disability, and other losses that preceded death. Yet research on health effects has yet to develop information that will support the formulation of a substantially more sophisticated relationship.

The trends for sulfur dioxide levels are well established. Over the past decade, ambient SO_2 levels in the air of our largest cities have decreased about 50 percent, although individual urban areas exhibited substantial variations.[21] A simple comparison of this decrease with the curve shown in Figure 17 would seem to suggest a 0.3 percent reduction in the mean death rate. Similarly, if ambient levels were allowed to climb to the primary standard, the figure would predict a 0.5 percent increase in the death rate. For the nation, 0.3 percent of the roughly 2 million deaths is 5,000 fewer deaths each year.

But it is simplistic to attribute death to the sole factor of air pollution. Clearly, people would die in the absence of air pollution. The

Figure 17

Relationship of Daily Sulfur Dioxide Levels and Daily Mortality Rates in the New York City Metopolitan Area



Source: A. Hershaft and G. Shea, "Assessment of the Interpretive Utility of Air Pollution Damage Functions," prepared by Enviro Control, Inc. for the Council of Environmental Quality under Contract No. EQ5AC012, 1975, based on R.W. Buechley et al., "SO_2 Levels and Perturbations in Mortality," Archives of Environmental Health, XXVII (September 1973), 134; M. Glasser and L. Greenberg, "Air Pollution Mortality and Weather: New York City 1960-1964," presented at the annual meeting of the American Public Health Association, Philadelphia, Nov. 11, 1969.

key is the change in life expectancy resulting from a change in SO_2 levels. When a relationship has been established, one can apply other economic factors—such as loss of productive days and medical and hospital costs—to compute the damage to society.

Another type of damage function relates photochemical oxidant levels to crop damage. Interest in the effects of oxidants on vegetation was aroused recently by the discovery of high oxidant levels in rural areas and by the publication of results of controlled experiments revealing unexpectedly high yield losses attributed to oxidant exposure. EPA estimates 1973 crop losses from high oxidant levels at nearly $3 billion.[30]

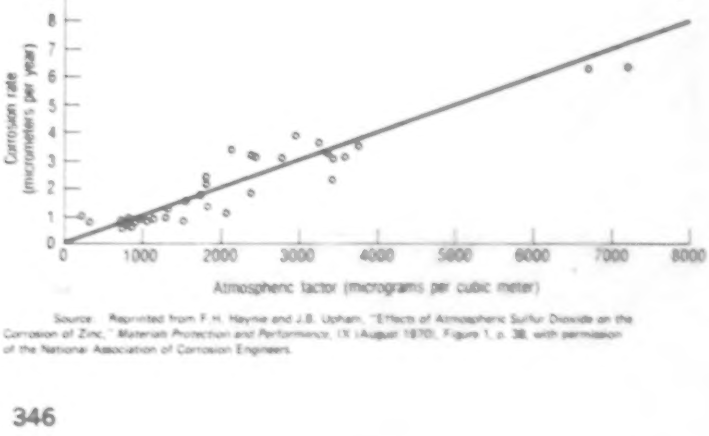
Reasonable damage functions have been developed for several plant species, such as the Bel-W_3, a sensitive variety of tobacco. A damage function that relates oxidant exposure to leaf injury, an important measure of damage for the tobacco plant, has been developed.[31]

A damage function is presented for the effects of sulfur dioxide on zinc surfaces in Figure 18. Corrosion of metals is the most substantial component of air pollution damage to materials, accounting for over $1.6 billion in 1973. Steel, in turn, is the most widely used metal, and in many applications involving exposure to the atmosphere, steel is coated with zinc by galvanization. The effects on zinc thus illustrate damage to materials from pollution.

Once the zinc coating has been breached, the steel corrodes at a much faster rate. A part of the reason is the higher reactivity of steel, but also a galvanic potential is generated at the interface of the two metals.

Figure 18

Effects of Sulfur Dioxide and Relative Humidity on the Corrosion Rate of Zinc



Source: Reprinted from F.H. Haynie and J.B. Upham, "Effects of Atmospheric Sulfur Dioxide on the Corrosion of Zinc," *Materials Protection and Performance*, IX (August 1970), Figure 1, p. 38, with permission of the National Association of Corrosion Engineers.

The corrosion rate is usually influenced by humidity and temperature as well as by the sulfur dioxide. On the basis of a series of controlled experiments, the damage function shown in Figure 18 expresses the corrosion rate of zinc as a function of an atmospheric factor that formed as a product of the concentration of SO_2 and a number that is related to relative humidity. Thus, changes in the atmospheric factor are directly proportional to variations in sulfur dioxide levels.

Using Figure 18 as a basis for calculation, one can roughly estimate that a 50 percent decrease in ambient SO_2 levels over the past decade would have reduced corrosion rates from 0.8 to 0.4 micrometers per year, doubling the life expectancy of zinc surfaces.

It is fair to say that although air pollution damage functions are in the very early stages of development, they may be of real assistance in allocating resources among many conflicting demands for pollution control and other national needs.

CONCLUSION

By most conventional methods of measurement, air quality in the United States has greatly improved during the 5 years since passage of the Clean Air Act Amendments. Estimated emissions of particulate matter have dropped about 29 percent, and smaller reductions have also occurred in sulfur dioxide, carbon monoxide, and hydrocarbon emissions on a nationwide basis. Ambient levels of particulate matter declined an average of 14 percent over this period, and average sulfur dioxide concentrations declined about 25 percent. The overall violation frequency for the ambient air quality standards for these pollutants has also dropped significantly. Moreover, many urban locations show improvement in ambient levels of carbon monoxide and photochemical oxidants.

These improvements are encouraging and have obviously benefited the nation's health and welfare. Yet undesirably high levels of the major air pollutants continue to occur at many locations. Only about one-third of the nation's 247 air quality control regions are fully meeting the health protection ambient standards for all pollutants at present. Violations of these standards still occur in 118 regions for particulate matter, 34 regions for sulfur dioxide, 69 regions for carbon monoxide, 79 regions for oxidants, and 16 regions for nitrogen dioxide.

In addition, deficiencies in the coverage and quality of our monitoring data may well obscure some of our air pollution problems. Siting, sampling, and analytical practices at air monitoring stations are not uniformly good. Furthermore, ambient standards are lacking and monitoring data are scarce for some of the pollutants believed to be most important to public health, including the respirable fraction of airborne particulate matter as well as particulate sulfates, nitrates, trace metals, and organics.

WATER QUALITY

Just as there is no single measure of human health, there is no single measure of water quality. Rather, there are dozens of specific physical, chemical, and biological characteristics of the nation's waters. Dissolved oxygen, coliform bacteria, temperature, nutrients, trace metals, and pesticides are some of the variables affecting water quality. It is typically found that in a given waterway over several years, a few of these measurable characteristics have generally improved, a few are worse, and the others have not significantly changed. Many waterways exhibit good water quality at some locations and at given times of the year but show signs of degradation at other times or other places. The nation's streams, lakes, estuaries, and coastal marine waters also vary considerably in size, geological features, flow characteristics, climate and meteorological influences, and the type and extent of human impacts on them. All these factors affect water quality.

Most definitions of water quality depend upon how suitable the waters are for particular uses and purposes. For example, it is one thing to evaluate the lower Mississippi River as a public drinking water supply and quite another to evaluate Lake Erie for swimming, a small stream in Michigan for trout fishing, the South Platte River for irrigation, or the Chesapeake Bay for commercial shellfishing. Water quality must be evaluated differently for each of these uses.

Each water use is sensitive to different pollutant levels, and water quality in a particular area or at a particular time may improve for one purpose but worsen for another. For example, sufficient dissolved oxygen is critical to fish and other aquatic life but of little

Water quality evaluations require the analysis of dozens of chemical, physical, and biological characteristics of water samples.

significance to drinking water supplies or swimming. On the other hand, the presence of coliform bacteria—indicators of sewage and possible pathogenic microorganisms—is a classic water pollution measure for drinking water or swimming but not for most industrial uses or for aquatic life. Trace metals and pesticides can seriously affect drinking water supplies and aquatic life, but they normally mean less to recreational swimming or boating uses of a waterway. Even when a particular water quality variable is important to more than one type of use, it must be assessed separately in relation to each type of use. For a given water pollutant, the "critical concentration" at which one use begins to be impaired may be quite different from the level at which another use is affected.

WATER QUALITY CRITERIA

The Federal Water Pollution Control Act Amendments of 1972[24] set nationwide 1983 water quality goals to provide for the protection and propagation of fish, shellfish, and wildlife and for human recreation in and on the waters. Under section 304(a) of the amendments, EPA was directed to reevaluate water quality criteria in terms of these and other water quality goals and to publish new criteria to reflect the most current scientific knowledge about water pollutants and their effects.

EPA is considering 60 quantitative criteria covering 43 water quality variables and 4 categories of beneficial water uses—aquatic

To millions of Americans, recreational fishing is an important beneficial use of the nation's waters.

life protection, public water supply, swimming, and irrigation. A comparison of the draft 1975 criteria [25] with those which have been in effect since 1968 [26] shows that 20 criteria are virtually the same, 3 are less stringent, 7 are more stringent, and 30 new criteria have been added; they are listed in Table 14. Although the basis for most of the 1968 criteria was the protection of public drinking water, 29 of the 35 new criteria are designated for the protection of aquatic life.

The new water quality criteria are being considered as federal recommendations, not legally enforceable ambient standards. It is expected that in many areas, the states will adopt many new criteria as standards, but in others the criteria may be modified to allow for special natural characteristics of some water bodies or geographic regions as well as for economic considerations.

TRENDS IN WATER QUALITY

There is growing evidence that some of our worst water quality problems have been diminishing. Fish populations are recovering in streams and lakes that have not been hospitable habitats for years, and many beaches are being reopened. But serious problems remain with respect to specific pollutants and certain water bodies.

Last year's Annual Report summarized the findings of EPA's first National Water Quality Inventory, which generally found that over the past decade, significant improvements have occurred in most major waterways in terms of organic waste loads, coliform bacteria, and other pollutants that have been the subject of most efforts to control point source pollution. On the other hand, the measured levels of nutrients that accelerate eutrophication have increased.

One way to obtain an overall picture of the improvements is by using indicators that summarize many water characteristics simultaneously. CEQ, EPA, and the U.S. Geological Survey are currently sponsoring a study in which more than 50 water quality indicators are being evaluated. It is described in more detail in Chapter 7. One of these indicators is the composite frequency of observed violations of all water quality criteria and standards. Figure 19 presents such an indicator. It illustrates the frequency with which "benchmark" levels for water quality variables have been exceeded at 87 monitoring stations of the Geological Survey's National Stream Quality Accounting Network (NASQAN). This network was selected for demonstrating the indicator because it has a long monitoring history, a fairly good nationwide distribution on major waterways, and reasonably uniform data collection methods.

The indicator is based on EPA's draft water quality criteria where they are available or on other benchmark levels where they are not. Most of the other benchmarks were based on state water quality standards, but for some variables lacking both federal and state

Table 14

Proposed (1975) Water Quality Criteria[1] Compared with 1968 Criteria

Variable	Aquatic life protection	Public water supply	Recreational bathing	Irrigation
General variables				
Alkalinity	⊙			
Ammonia	+			
Boron				⊙
Chloride		⊙		
Chlorine	+			
Color		⊙		
Cyanide	+	⊙		
Fecal coliforms			⊙	
Nitrate		⊙		
pH	>	<		
Phenols	+	⊙		
Phthalate esters	+			
PCB's	+			
Sulfate		⊙		
Sulfide/hydrogen sulfide	+			
Suspended solids	+			
Trace metals				
Antimony	+			
Arsenic	+	<		>
Barium		⊙		
Beryllium	+			>
Cadmium	+	⊙		
Chromium	+	⊙		
Copper		⊙		
Iron	+	⊙		
Lead		⊙		
Manganese		⊙		
Mercury	+	+		
Nickel	+			>
Selenium	+	⊙		
Silver	+	⊙		
Zinc	+	⊙		
Pesticides				
Demeton	+			
Endosulfan	+			
Endrin	+			
Guthion	+			
Lindane	+	>		
Malathion	+			
Methoxychlor	+	<		
Mirex	+			
Parathion	+			
Toxaphene	+	⊙		
2,4–D		>		
2,4,5–T		>		

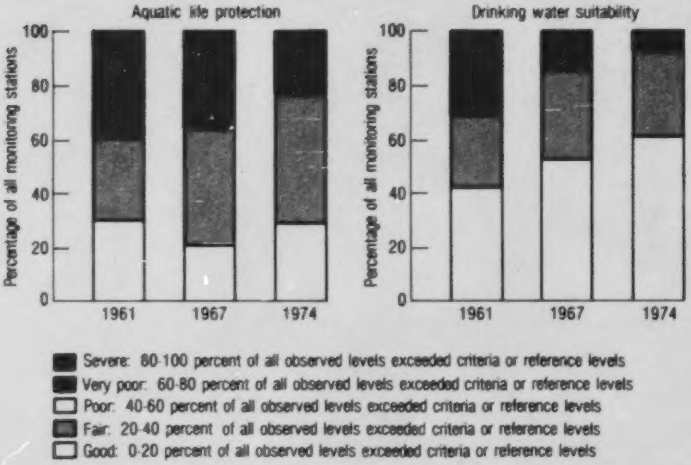
⊙ = Remained the same or equivalent
< = Became less stringent
> = Became more stringent
+ = Newly added.

[1] Draft criteria under consideration by EPA as of August 1975; the criteria may be modified prior to their promulgation.

Source: Environmental Protection Agency.

Figure 19

Summary of Water Quality Observations Related to Aquatic Life Protection and Drinking Water Suitability, 1961, 1967, and 1974[1]



[1] Taken at 87 stations of the U.S. Geological Survey's National Stream Quality Accounting Network.

Source: Energy Resources Company, Inc., "Comparative Evaluation of Techniques for the Interpretive Analysis of Water Quality," draft, 1975.

standards, they were set to approximate safe levels for aquatic organisms (see Table 15 for the levels used).

Figure 19 shows the composite frequency of violations of aquatic life protection criteria and benchmarks for all extensively measured NASQAN water quality variables. This indicator shows a reduction in the composite frequency of violations—an improving trend. The proportion of NASQAN stations in the good or fair categories (violation frequencies of less than 40 percent) increased from 61 to 77 percent between 1961 and 1974. Perhaps more significantly, the proportion of stations in the very poor and severe categories (60 percent or more of all measurements in violation) dropped from 16 to 3 percent over these years, and no stations were in the severe category in 1974.

The figure employs the same type of indicator to illustrate 1961–74 changes in the composite violation frequency for drinking water protection. The improvements in drinking water suitability as measured by this indicator are even more pronounced than those seen for aquatic life. In 1974, 92 percent of all stations registered in the good or fair categories, compared with 69 percent in 1961. Further, the two worst categories which characterized 10 percent of all stations in 1961 were reduced to 1 percent in 1974.

Table 15

Water Quality Criteria and "Benchmark" Levels Used in the Summary Indicators of National Stream Quality Accounting Network (NASQAN) Trends

Variable	Aquatic life protection	Public water supply
General		
Alkalinity (mg/l)	85	—
Biological oxygen demand (mg/l)	8	—
Boron (mg/l)	—	1.0
Chloride (mg/l)	250	250
Color (units)	75	15
Conductance (μ mho)	600	750
Cyanide (mg/l)	5	200
Dissolved oxygen	5.1	10
Nitrate (mg/l)	0.6	10
Ph	6.5–9.0	5.0–9.0
Phosphorus (mg/l)	0.03	—
Sulfate (mg/l)	250	250
Temperature (°C)	33	33
Total dissolved solids (mg/l)	500	500
Total solids (mg/l)	580	580
Trace metals		
Arsenic (μg/l)	50	50
Cadmium (μg/l)	4	10
Copper (μg/l)	10	1,000
Iron (μg/l)	300	300
Lead (μg/l)	30	50
Manganese (μg/l)	100	50
Zinc (μg/l)	100	5,000
Pesticides		
DDD	0	0
DDE	0	0

Source: Energy Resources Company, Inc., "Comparative Evaluation of Techniques for the Interpretive Analysis of Water Quality," prepared for Council on Environmental Quality, Environmental Protection Agency, and U.S. Geological Survey under Contract no. EQ5AC014 (draft, 1975).

Although the figure shows some encouraging trends, it is necessary to emphasize that it illustrates only one type of summary indicator. This kind of indicator summarizes massive amounts of diverse data; it must be viewed cautiously and serves only as a guide. It does not necessarily indicate that the water quality in any particular water body was good, poor, or severe but simply that the composite indicator fell within the good, poor, or severe ranges. Scientific assessments that may be viewed with confidence always require detailed study of specific local conditions in individual water bodies with respect to specific uses. In addition, there are a number of water pollutants for which no criteria are designated and very little monitoring data exist—the trace organic chemicals, for example. They are not represented here in the summary indicators.

A somewhat similar procedure may be used for individual pollutants. Table 16 provides such an analysis, showing the frequency with which each of the draft EPA water quality criteria was violated at

Table 16

Composite Frequency of Observed Violations of Proposed (1975) Water Quality Criteria,[1] 1968–74

Variable	Aquatic life protection	Public water supply	Recreational bathing	Irrigation
General variables				
Alkalinity	▽			
Ammonia	▲ (9) [59]			
Boron				▽
Chloride		▽		
Chlorine	?			
Color		▽		
Cyanide	▲ (22) [28]	▽		
Fecal coliforms			▲ (39) [89]	
Nitrate		▽		
pH	▽	▽		
Phenols	▲ (38) [59]	▲ (38) [59]		
PCB's	?			
Phthalate esters	▲ (9) [13]			
Sulfate		▽		
Sulfide/hydrogen sulfide	?			
Suspended solids	▽			
Trace metals				
Antimony	?			
Arsenic	▽	▽		▽
Barium		▽		
Beryllium	?			▽
Cadmium	▽	▽		
Chromium	▽	▽		
Copper		▽		
Iron	▲ (11) [32]	▲ (45) [66]		
Lead		▲ (6) [15]		
Manganese		▲ (48) [64]		
Mercury	▲ (34) [44]	▽		
Nickel	▽			▽
Selenium	▲ (6) [11]	▲ (6) [11]		
Silver	▽	▽		
Zinc	▲ (24) [43]	▽		
Pesticides				
Demeton	?			
Endosulfan	▽			
Endrin	▽			
Guthion	▽			
Lindane	?	?		
Malathion	▽			
Methoxychlor	?	?		
Mirex	?			
Parathion	▽			
Toxaphene	?	?		
2,4-D		?		
2,4,5-T		?		

▲=More than 5 percent of all 1968–74 measurements were made in violation of draft 1975 criteria; ▽=5 percent or less of all 1968–74 measurements were in violation of draft 1975 criteria; ?=insufficient 1968–74 data are available to determine status; ()=actual frequency of violations; []=percentage of monitoring stations recording violations.

[1] Draft criteria under consideration by EPA as of August 1975; the criteria may be modified prior to their promulgation.

Source: Environmental Protection Agency.

thousands of monitoring stations across the country from 1968 to 1974 and the percentage of stations reporting the violations.

This analysis is based on approximately 887,000 of the individual measurements contained in STORET, EPA's computer-based information system for water quality data.[27] The data originated mostly in routine water monitoring programs of the states, EPA, and other federal agencies. They represent only surface freshwater measurements. No data were included on ground waters, effluents, or marine waters.

Fourteen of the 60 draft criteria were violated frequently (from 6 to 48 percent of the time), 31 criteria were not frequently violated, and for 15 additional criteria, conditions cannot be summarized because sufficient data were not available.

Of the 14 frequently violated criteria, 8 new ones for the protection of aquatic life had not been in effect during the time covered. The remaining 6 were the drinking water criteria for phenol, iron, lead, manganese, and selenium and the recreational bathing criterion for fecal coliform bacteria.

Violations of the new aquatic life criteria show that the problem of trace metals is widespread, with 32 to 44 percent of all reporting stations indicating violations for iron, mercury, and zinc. Violation frequencies for metals ranged from 6 to 34 percent of all observations. Ammonia problems are similarly widespread but the frequency of violations is rather small. Phenol violations were observed often and at most stations. For certain pollutants, however, the figures on the percentage of stations reporting violations are somewhat misleading. For example, 7 of the 23 states reporting ammonia measurements were responsible for most of the violations. The pesticide measurements are too limited geographically and in number to indicate the seriousness of the problem nationwide.

NUTRIENTS AND EUTROPHICATION

The 1974 National Water Quality Inventory found worsening nationwide trends in nutrient levels.[28] More extensive information is now available from EPA's National Eutrophication Survey.[29] Conducted from 1972 to 1975, it indicated that most lakes studied in the Eastern states are suffering some degree of accelerated eutrophication. This condition is primarily attributed to the nutrients, often phosphorus, that drain from agricultural and urban land, although industrial effluents and municipal sewage treatment plants also contribute.

Eutrophication, or nutrient enrichment, is measured by the biological productivity of freshwater lakes. Productivity depends largely on the supply and balance of chemical nutrients. Lakes supplied with large amounts of nutrients tend to be the most productive biologically. This relationship is a major part of the basis for the trophic system of lake classification. In the first stage—the oligotrophic—a lake is "young," the water contains low nutrient levels, and biological life is sparse. Over time, as nutrients and sediments are added, a lake becomes more biologically productive and often becomes shallower. It is in the mesotrophic state. As nutrients continue to be added, algal blooms may appear, fish populations may be altered, often undesirably, and the lake frequently becomes less useful to humans. The final stage is called the eutrophic stage, and the process leading to it is known as eutrophication.

Eutrophication is a natural process, naturally taking place over thousands or even millions of years. But by contributing increased nutrients and sediments, human activities can produce the same effect in a few decades. The physical characteristics of a lake often help to determine its particular response to human activities. The shallow water environments of many bays and inshore waters that receive wastes often change the most significantly. Thus, while a lake as a whole may be classified as oligotrophic, certain of its shallow areas may be eutrophic. The eutrophic condition may eventually reach the open lake, but because of the deeper waters in offshore areas, the changes there are usually more gradual. Unfortunately, the shallow water environments that are first altered by pollution are normally the most important for water supply, fish production, and recreation.

The principal goal of the National Eutrophication Survey was to investigate the extent and causes of accelerated eutrophication in freshwater lakes and reservoirs. Information was obtained about their trophic status, nutrient loadings, tolerance to various levels of individual nutrients that control the growth of algae and other plants, and the probable effects of planned phosphorus removal at

Helicopters were used by EPA to take samples of lake water in the National Eutrophication Survey.

sewage treatment plants and other sources. The large sampling effort—812 lakes—was made possible through the cooperation of EPA, many state agencies and National Guard units, the U.S. Geological Survey, and the Department of Defense. Their general locations are shown in Figure 20.

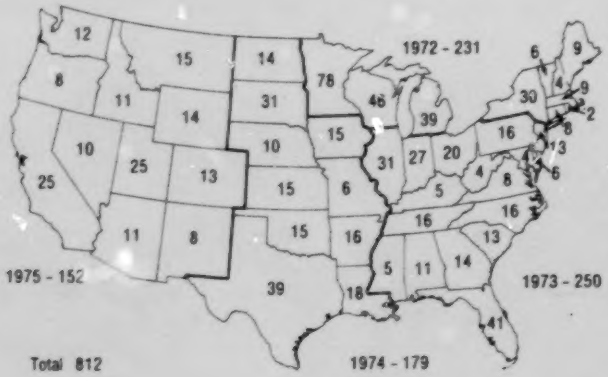
Experiments were conducted to determine which nutrient is most limiting—in effect, controls—the growth of algae in each lake. On the average, most freshwater algae normally require and use about 10 to 15 times more nitrogen than phosphorus for growth.[30] When a particular nutrient is not available to the algae in usable form in its required proportion, the local scarcity of that nutrient may become the limiting or controlling factor which determines the rate of algal growth. Then any artificial addition of that particular nutrient may stimulate new algal growth, whereas the addition of a nutrient that was already sufficiently available will not do so.

Table 17 shows that phosphorus was identified as the limiting nutrient in 65 percent of the 466 eastern lakes sampled in 1972 and 1973. Nitrogen was limiting in 28 percent of the lakes.

Despite the fact that phosphorus is normally easier to control than nitrogen, we have not been very successful—of 175 eastern lakes studied intensively, lakes for which considerable supplemental data were available, 149 (85 percent) exhibited accelerated eutrophication. Although 136 of these lakes received some effluents from point

Figure 20

Distribution of Lakes in the National Eutrophication Survey



Source: Environmental Protection Agency.

Table 17

Limiting Nutrients Identified by the National Eutrophication Survey

Year of sampling	Region	Number of lakes	Percent of lakes in which limiting nutrient is phosphorus	Percent of lakes in which limiting nutrient is nitrogen	Percent of lakes in which limiting nutrient is unknown
1972	10 Northeastern and North Central states	221	55	37	8
1973	17 Eastern, Southern, and Midwestern states	245	74	21	5
Total	27 states	466	65	28	7

Source: Environmental Protection Agency, National Eutrophication Survey, unpublished data.

sources, only 65 were expected to improve if advanced phosphate removal were achieved at the point sources. For most of the problem lakes, stemming accelerated eutrophication would appear to require control of nonpoint sources.

Nonpoint sources of nutrients entering the nation's water bodies are obviously tied to land use. To examine this relationship, the survey looked at land use patterns, geological and hydrological characteristics, and stream nutrient levels in approximately 1,000 drainage areas across the country: 143 in the Northeastern and North Central states, 382 areas in the Eastern, Southern, and Midwestern states, and approximately 500 in the Western states.

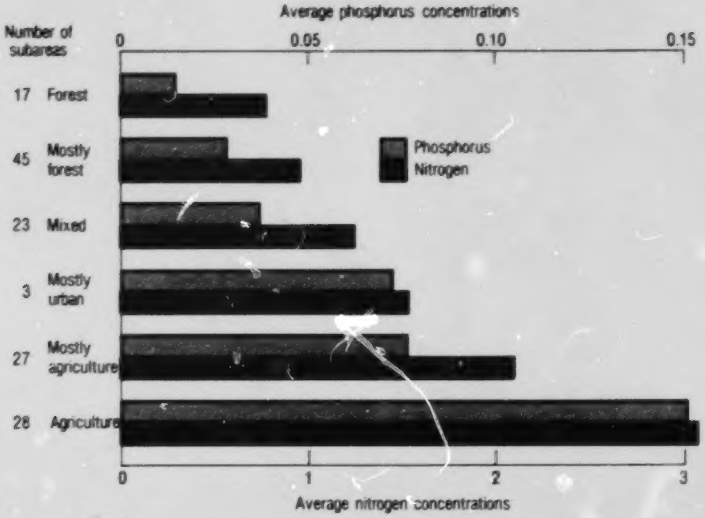
For the first group of drainage areas studied, land use conditions were compared with measured stream nutrient concentrations. Although slope, soils, and climate are important influences, the type of land use clearly is related to nutrient concentrations in local streams, as shown in Figure 21. Both phosphorus and nitrogen are markedly more concentrated in agricultural and urban areas than in other areas.

In attempting to study hundreds of lakes, streams, and drainage areas, the National Eutrophication Survey obviously could not study each one intensively, but it did provide a uniform comparison of many water bodies. Most of the findings are consistent with but have expanded upon those of previous studies. Used in conjunction with the results of more detailed studies of individual water bodies, survey findings are valuable contributions to characterization of nationwide water quality conditions, and they can help in the formation of regulatory and management strategies.

Figure 21

Relationship of Average Phosphorus and Nitrogen Concentrations to Land Use

(in milligrams per liter)



Source: Environmental Protection Agency, National Eutrophication Survey, *Relationships Between Drainage Area Characteristics and Non-Point Source Nutrients in Streams*, Working Paper No. 25 (Corvallis, Oreg.: 1974), Figure [illegible].

FEDERAL WATER QUALITY MONITORING NETWORKS

National Water Quality Surveillance System

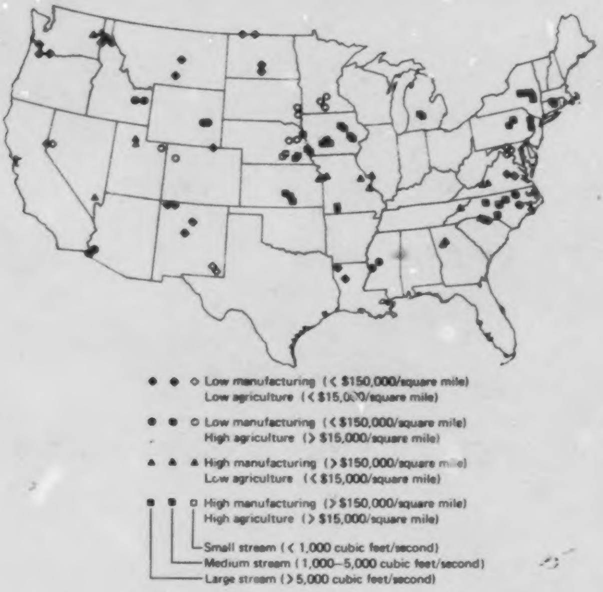
The relationship of land use to water quality will be evaluated on a continuing basis by EPA's National Water Quality Surveillance System. Established under section 104(a)(5) of the 1972 Federal Water Pollution Control Act Amendments,[31] the NWQSS began regular operations in 1974. Its primary purpose is to monitor water quality in representative areas of the country and to identify ways in which land use conditions affect stream quality. Approximately 70 pairs of monitoring stations are now operating in the system. They are identified in Figure 22.

Specific locations were selected jointly by EPA and the states to represent different types of land use conditions. Most of the actual NWQSS monitoring activities are being performed by the U.S. Geological Survey.

At least 30 water quality variables are reported every 2 weeks at each station. Pairs of stations are sited upstream and downstream

Figure 22

National Water Quality Surveillance System Stations, Classification of Land Use, and Stream Size


Low manufacturing (< $150,000/square mile)
Low agriculture (< $15,000/square mile)
Low manufacturing (< $150,000/square mile)
High agriculture (> $15,000/square mile)
High manufacturing (> $150,000/square mile)
Low agriculture (< $15,000/square mile)
High manufacturing (> $150,000/square mile)
High agriculture (> $15,000/square mile)
Small stream (< 1,000 cubic feet/second)
Medium stream (1,000–5,000 cubic feet/second)
Large stream (> 5,000 cubic feet/second)

Source: Environmental Protection Agency.

from selected drainage areas, so that each pair of stations brackets an area. About one-third of the stations are sited on small streams, another third on medium-size streams, and the rest on large rivers.

In each NWQSS drainage area, land use is characterized according to industrial and agricultural activities and human population densities. Their effects on an area's water quality are being estimated by comparing them with the measured upstream-downstream differences in water quality variables.

The first year's data for the downstream stations have been compared to the EPA draft water quality criteria. The frequency of violations is given in Table 18. The most frequent violations observed in 1974 were for ammonia, fecal coliform bacteria, and four trace metals, iron, lead, manganese, and zinc.[32]

With the NWQSS stations it is possible to relate water quality conditions to land use in the basins being monitored. As shown in Table 19, violation frequencies for the identified problem pollutants were closely related to local manufacturing activity, and fecal coliform bacteria, nitrate, and nitrite levels paralleled agricultural activity.

Table 18

Average Frequency of Observed Violations of EPA's Proposed (1975) Water Quality Criteria at National Water Quality Surveillance System (NWQSS) Stations, 1974

Variable [1]	Average frequency of violation of criterion [2] (percentage of all measurements)	Number of monitoring stations	Number of observations
General variables			
Ammonia	11	52	844
Chloride	6 [3]	53	680
Dissolved oxygen	4	52	1,120
Fecal coliform bacteria	67	47	907
pH	8 [4]	56	1,168
Sulfate	18 [5]	53	645
Suspended solids	5	44	791
Trace metals			
Arsenic	Less than 1	33	397
Cadmium	Less than 1	36	454
Chromium	Less than 1	39	463
Iron	53	49	744
Lead	16	35	471
Manganese	84	37	424
Zinc	44	46	577

[1] Only those NWQSS-measured variables for which proposed criteria were under consideration as of August 1975 are included in this table.

[2] All water quality criteria considered in this table were designated for the protection of aquatic life, except those for fecal coliform bacteria (recreational bathing) and arsenic, manganese, lead, chloride, and sulfate (public water supply).

[3] If the station on Salt Creek, Nebraska, is excluded, the average NWQSS violation frequency for chloride was 3 percent.

[4] If the eight stations in North Carolina are excluded, the average NWQSS violation frequency for pH was 4 percent.

[5] If one station on the Colorado River is excluded, the average NWQSS violation frequency for sulfate was 5 percent.

Source: Environmental Protection Agency.

The levels of some other important water pollution variables, such as dissolved oxygen and suspended solids, seldom violated the criteria, and the distribution of violations that occurred did not appear related to the type or extent of land use activities.

National Stream Quality Accounting Network

NASQAN, which presently includes 345 monitoring stations, contains some of the nation's most valuable monitoring stations for assessing inland stream quality. It provides some of the best data available for evaluating long-term trends in many waterways and for rigorously examining the significance of observed short-term variations in water quality. These variations may be caused by a variety

Table 19

Average Violation Frequencies, by Land Use, for Selected Variables Measured at All National Water Quality Surveillance System (NWQSS) Stations, 1974 [1]

Variable	Manufacturing		Agriculture	
	High activity	Low activity	High activity	Low activity
Ammonia	15	8		
Fecal coliform bacteria	79	52	72	61
Nitrate and nitrite	30	17	35	11
Trace metals [2]	52	42		

[1] The violation frequencies are expressed as percentages of all NWQSS measurements which exceeded EPA's draft water quality criteria for each variable. Only frequencies showing a statistically significant difference (for manufacturing or agriculture) at the 95 percent confidence level are illustrated.

[2] Composite average for iron, lead, manganese, and zinc only.

Source: Environmental Protection Agency.

of natural factors, and they would occur even if human activities had no effect on water quality. For example, flow rates and levels of dissolved and suspended materials fluctuate with the amount of rainfall on a drainage area. NASQAN allows interpretation of water quality measurements provided by other monitoring systems.

In late 1974, the Geological Survey completed the first assessment of long-term trends in water quality at 88 NASQAN stations, shown in Figure 23. Its findings are summarized for several important water quality parameters and specific streams in Table 20. Most of these findings concern the geographical variations and chemical differences among the streams monitored. However, the NASQAN assessment included time trend analyses for temperature and electrical conductivity, a measure which can approximate the amount of dissolved material. Improvements were observed in most of the statistically significant time trends for temperature; conductivity trends were mixed.

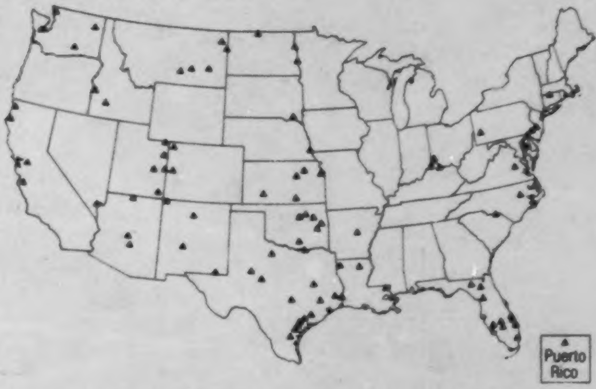
CONCLUSION

It is clear that our efforts to restore and protect our nation's waters have made some encouraging progress. The water quality indicators, trend analyses, and studies all show that many of the worst point sources of pollution are being effectively controlled and that some of our most heavily polluted waterways are being cleaned up.

These same evaluations also clearly indicate that nutrients, trace metals, and land runoff are going to present difficult and persistent challenges to the national commitment to improving water quality.

Figure 23

Location of National Stream Quality Accounting Network (NASQAN) Stations Included in the 1974 National Assessment



Source: T.D. Steele, E.J. Gilroy, and R.O. Hawkinson, *An Assessment of Areal and Temporal Variations in Streamflow Quality Using Selected Data from the National Stream Quality Accounting Network*, USGS Open-File Report 74-217 (Reston, Va.,1974).

As additional data become available, it is also likely that a number of toxic organic chemicals will be added to the list of challenging problems.

HAZARDOUS POLLUTANTS

Some of the complex chemicals created by modern technology are hazardous to human beings. They can directly cause death, serious irreversible disease, or long-term effects that lead to cancer or genetic mutation. They are governed by a considerable body of federal law and regulation, dating back to the first pesticide control law in 1910.[23]

This section focuses on four substances—DDT, aldrin/dieldrin, PCB's, and mercury—that have come under new restrictions in recent years as scientists have gained a better understanding of their fate, persistence, and hazardous nature.

What are the results of the new limitations? To what extent have soil and water improved since these toxic pollutants were restricted or banned? Have affected birds and fish and other wildlife shown signs of recovery? What about the concentration of these pollutants in our food supply and in human tissues? Is the presence of these hazardous substances in the environment still a matter of concern? So far as present information can take us, we attempt to answer these questions.

Table 20

Summary of the U.S. Geological Survey Water Quality Assessment Report

Region	Description	Number of stations	Specific conductance trends [1]	Temperature trends		Streamflow [3]	Chlorides [3]
				Mean	(Annual variation) [2]		
I	Atlantic coast (above Florida)	7	Deterioration in chemical quality noted at Schuylkill River, Philadelphia, Pennsylvania	—	—	Moderate to high discharge	Low levels
II	Florida and eastern Gulf	12	No significant changes noted	D1	—	Low to moderate discharge	Low to moderate levels
III	Ohio River basin	4	Data lacking on concurrent stream discharge	—	—	No data at two stations: Great Miami River, Elizabethtown, Ohio; Ohio River at Markland Dam near Warsaw, Kentucky; other stations moderate and high	Low levels
IV	Souris, Red, and Missouri basin	13	Deterioration in chemical quality at Tongue River, Miles City, Montana; Missouri River, Nebraska City, Nebraska	—	D1	Highly variable from station to station; range moderate to high	Low to moderate levels
V	Arkansas and Red River basins	12	Improvement in chemical quality at: Arkansas River, Tulsa, Oklahoma; Arkansas River, Little Rock, Arkansas; Canadian River, Whitefield, Oklahoma	—	—	Moderate to high discharge values	Low to high levels
VI	Texas Gulf and Rio Grande	17	Chemical quality improved at Guadalupe River, Victoria, Texas and deteriorated at Beals Creek, Westbrook, Texas; Colorado River, Austin, Texas	D2	D2	Highly variable, moderate due to extreme variations in rainfall, except for Beals Creek, Westbrook, Texas, which was low	Generally moderate to high levels Excessive at 3 stations [4]

VII	Colorado River basin	12	Chemical quality improved at Gunnison River, Grand Junction, Colorado and deteriorated at: Green River, Greendale, Utah; Yampa River, Maybell, Colorado	—	D2	Relatively moderate discharge values	Low to moderate levels
VIII	Pacific coast	10	Deterioration in chemical quality at San Joaquin River, Vernalis, California; Klamath River, Klamath, California; Boise River, Notus, Idaho	D2	—	Moderate to high discharge values	Low to moderate levels
IX	Puerto Rico	1	No significant change	—	—	Low values	Low levels

Region	Description	Nitrates [3]	Total hardness [3]	Dissolved solids [3]	Specific conductance (areal conditions) [3]
I	Atlantic coast (above Florida)	Low levels with one exception (moderate): Schuykill River, Philadelphia, Pennsylvania	Low levels (soft water) with one exception (moderate): Schuykill River, Philadelphia, Pennsylvania	Low levels	Low values with exception at 1 station: Schuykill River, Philadelphia, Pennsylvania
II	Florida and eastern Gulf	Low levels	Low to high levels	Low to moderate levels	Low to moderate values
III	Ohio River basin	Low levels at Allegheny River, Oakmont, Pennsylvania; Licking River, Mckinneysburg, Kentucky. Moderate levels at Great Miami River, Elizabethtown, Ohio; Ohio River at Markland Dam near Warsaw, Kentucky	Moderate to high levels	Moderate levels	Moderate levels (data lacking)
IV	Souris, Red, and Missouri basin	Low levels with exceptions	Moderate to high levels	Moderate to high levels	Moderate to high levels; highly variable from station to station

See footnotes at end of table.

Table 20—Continued

Summary of the U.S. Geological Survey Water Quality Assessment Report

Region	Description	Nitrates[2]	Total hardness[2]	Dissolved solids[2]	Specific conductance (areal conditions)[2]
V	Arkansas and Red River basins	Low to high levels	Moderate to high with one exception (low): Ouachita River, Monroe, Louisiana	Moderate to excessive levels	Relatively saline (moderate to high values) with exception at 1 station: Ouachita River, Monroe, Louisiana
VI	Texas Gulf and Rio Grande	Low to moderate levels	Moderate to high	Low to moderate at 12 stations, excessive at 5 stations.[1]	High rainfall—low to moderate values. Low rainfall—high values
VII	Colorado River basin	Low to moderate levels	Relatively high levels	Moderate to high levels	Relatively high values
VIII	Pacific coast	Low levels	Low to moderate levels with exception at 1 station: Salinas River; Spreckels, California	Low levels with exception at 1 station: Salinas River, Spreckels, California	Low values with exception at 1 station: Salinas River, Spreckels, California
IX	Puerto Rico	Low levels	Low levels	Low levels	Low values

[1] Temporal changes in specific conductance were determined by applying Kendall's tau statistic with significance level set at 0.01 to annual discharge-weighted mean specific conductance residuals (measured-estimated) determined from the conductance-discharge relation. (Changes in specific conductance attributed solely to corresponding changes in discharge were observed at four stations in the following regions: I. Atlantic coast above Florida; V. Arkansas and Red River basins; and VI. Texas Gulf and Rio Grande.

[2] Changes (taken as the difference between mean values for split periods) at the 95 percent or higher statistical confidence level. In every case a decrease, signified by the letter D, has been detected, i.e., the mean or annual variation for period two (most recent) is less than that for period one. Numerical code following the letter code indicates the number of stations within that region at which a significant change occurred. Significant changes in maximum temperatures are not included in this summary.

[3] Ranges for the constituent concentrations within each class; streamflow discharge classes established by USGS are highly dependent upon drainage area.

Class	Streamflow discharge (cfs)			Constituent		
		Chloride (mg/l)	Nitrate (mg/l)	Total hardness (mg/l)	Dissolved solids (mg/l)	Specific conductance (μmho/cm)
Low	<100	<50	<5	<50	<100	<150
Moderate	100–10,000	50–250	5–45	50–200	100–500	150–750
High	>10,000	250–1,000	>45	>200	500–1,000	750–1,500
Excessive	–	>1,000	–	–	>1,000	>1,500

[4] Brazos River, Seymour, Texas; Mission River, Refugio, Texas; Pecos River, Red Bluff, Texas.

[5] Brazos River, Seymour, Texas; Beals Creek, Westbrook, Texas; Colorado River, Ballinger, Texas; Mission River, Refugio, Texas; Pecos River, Red Bluff, Texas.

Source: T.D. Steele, E.J. Gilroy, and R.O. Hawkins, *An Assessment of Areal and Temporal Variations in Streamflow Quality Using Selected Data from the National Stream Quality Accounting Network*, USGS open-file report 74–217, August 1974; personal communication with R.J. Pickering, U.S. Department of the Interior, Water Resources Division.

DDT

Although DDT was first synthesized in 1874, its value as an insecticide was not recognized until 1939, when it saved the Swiss potato crop from the ravages of the Colorado potato beetle.[34] DDT performed a valuable service during World War II, when older pesticides were unavailable and combat troops had to be protected from typhus, malaria, and other insect-borne diseases. At that time, DDT's long-lasting residual effect was hailed as one of its chief advantages.

But within a dozen years, unwelcome side effects began to appear. Years of use led to development of resistant strains of insects, while nontarget species accumulated residues, often in toxic amounts.

DDT was implicated, for example, in the precipitous decline in population of such sea birds and birds of prey as the herring gull, brown pelican, and the double crested cormorant. DDT caused these species to form thin-shelled eggs that broke prematurely.[35] Museum studies show that eggshell thinning began to occur as early as 1947, soon after DDT was first used.[36]

Lethal effects on fish have also been observed. Accumulations of 5 parts per million DDT in the egg yolks of brook trout resulted in 100 percent mortality among the offspring.[37] Crabs, shrimps, and oysters accumulate DDT in lethal concentrations, even at very low levels of exposure. Concentrations of 0.[illegible] parts per billion caused 100 percent mortality in shrimp within 18 days; 0.12 parts per billion caused 100 percent mortality in 28 days.[38] Furthermore, in laboratory experiments DDT has produced increased incidence of tumors in mice,[39] presumptive evidence that DDT may be a human carcinogen.

Federal Actions

Effective December 31, 1972, EPA suspended virtually all uses of DDT on the grounds that continued use would pose an unacceptable risk to man and the environment.[40]

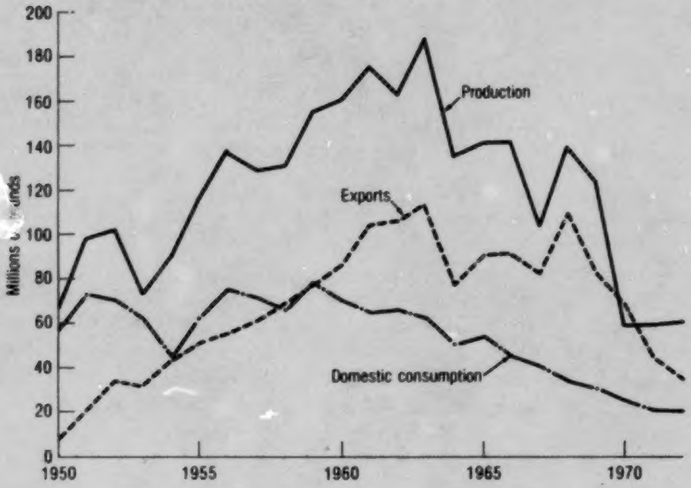
Commercial Flows

In the early 1950's, 13 U.S. companies were manufacturing DDT; by 1971 just 1 remained. Domestic production peaked at nearly 188 million pounds in 1963, declined about one-third by the late 1960's, and dropped to about 60 million pounds per year in the early 1970's. as shown in Figure 24.

Domestic use was highest in 1959, at nearly 79 million pounds, and dropped to about 20 million in 1971. The increase of an estimated 5 million pounds in 1972 may be partly explained by the fact that 2 million additional acres was planted in cotton that year. More may have been purchased in the expectation of a ban on DDT. Domestic consumption generally exceeded exports until 1960, when the trend clearly reversed. Since 1972, reported use of DDT in the United States has been limited to something less than 0.5 million pounds, nearly all against the tussock moth in Washington, Oregon, and

Figure 24

Domestic Production, Consumption, and Exports of DDT, 1950-72



Source: Environmental Protection Agency, based on Department of Agriculture data.

Idaho forests. That limited use of DDT by the Forest Service was permitted for 1974 only and none was planned for 1975.[41] The decreased DDT use is already reflected in measured residues in the environment.

Terrestrial Systems

DDT is more persistent in some environmental systems than others. Residues in soil degrade slowly. In Arizona, for example, where a moratorium on DDT use began in 1969, residues of DDT in cropland had not changed perceptibly 4 years later, as shown in Table 21. The data suggest that in an arid climate the soil half-life of DDT (the time required for one-half of the remaining DDT to wash out or break down) exceeds 20 years.[42]

Nationwide, the average level of DDT residues in soil has dropped from 0.36 parts per million in 1969 to 0.23 parts per million in 1973. Declines were statistically significant, but the rate of decline indicates that under normal environmental conditions DDT is stable in soil. Residue levels in crops grown in soils last treated with DDT in 1972 are likely to decline only slowly in the years to come.[43]

Investigators have reported DDT levels in terrestrial birds. A national monitoring program of chlorinated pesticides in starlings,

Table 21

DDT Residues in Arizona Soil [1]

(In parts per million)

County	January 1969	September 1970	September 1972
Maricopa	1.57	1.82	1.64
Pinal	1.60	1.61	1.55
Yuma	0.76	0.75	0.78

[1] The changes from year to year here are not significantly different at the 0.05 level.

Source: G. W. Ware, B. J. Estesen, and W. P. Cahill, "DDT Moratorium in Arizona—Agricultural Residues after 4 Years," *Pesticides Monitoring Journal*, 8(2) (September 1974), pp. 98–101.

begun in 1967, tentatively concluded in 1970 that DDT was "apparently declining from the baseline findings." [44] New data in 1972 confirmed that DDT levels in starlings had indeed declined significantly since 1967, falling to a projected mean for 1974 below 0.1 parts per million.[45] Migratory songbirds have also shown an unmistakable decline in DDT levels. Each autumn since 1964 samples have been collected from hundreds of birds killed when they strike television towers during migratory flights at night. Among 319 birds representing 10 species, none was free of DDT residues, but declines were clearly evident, as shown in Figure 25; in 5 species, levels dropped dramatically between 1969 and 1973, from a mean of 17.8 parts per million to 2.06.

Air Systems

DDT applied to the soil may evaporate into the air. In general, it is not a serious air pollutant. But air is a means of transport for DDT. Wind and rainfall carry it to soils and water, adding to the DDT burden already there. Monitoring of airborne levels helps to determine the ultimate fate of this kind of pollutant. Data are extremely scanty, so no trends can be identified.

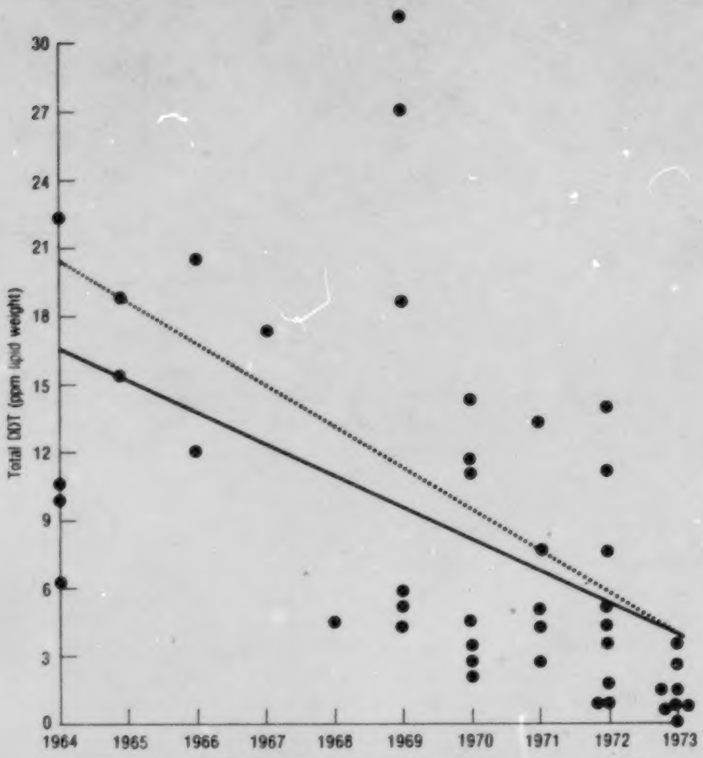
In 1969, DDT in the air (and in rainwater which washed the air) varied according to locality and season, with lower concentrations in urban areas and higher concentrations in agricultural areas, particularly in the summer. Measured concentrations in ambient air have ranged from 0.1 nanograms per cubic meter to 1.56 micrograms per cubic meter in the United States and averaged in rainfall from levels of 3 parts per trillion to 187 parts per trillion. Levels of 40 parts per trillion have been found in Antarctic snow.[46]

Freshwater Systems

Water samples indicate that the total pesticide content of U.S. surface waters fell off sharply between 1964 and 1968.[47] Specifically, a

Figure 25

DDT Residues in Migratory Songbirds, 1964-73[1]



[1] The solid line represents 10 species of migratory birds. A subset of 7 species whose diet is mainly tree insects is represented by the dotted line. Each point represents a pooled sample for one species.

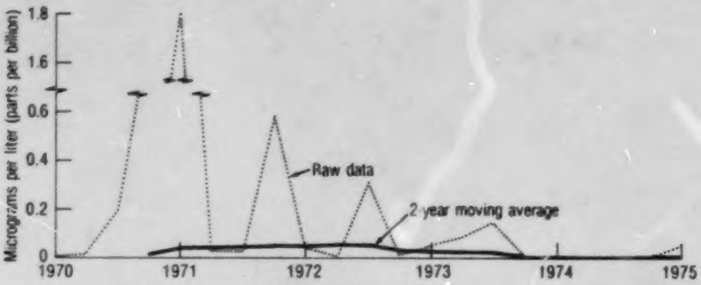
Source: David W. Johnston, "Decline of DDT Residues in Migratory Songbirds," *Science*, 29 (Nov. 29, 1974), Figure 1, p. 824; © 1974 by the American Association for the Advancement of Science.

preliminary analysis of available water quality data for 1970–74 shows a continuous decline in DDT levels consistent with the trend in domestic consumption (Figure 26). Because of distortions, however, the data are not statistically significant at this time.

The effect of DDT restrictions has been demonstrated in the Great Lakes. In the mid-1960's several investigators found DDT contamination in Great Lakes fish. The problem was especially severe in Lake Michigan, where residues in several species exceeded the FDA maximum allowable concentration of 5.0 parts per million. A 1969 ban on DDT use in part of the Lake Michigan watershed, including Indiana, Michigan, and Wisconsin, led to a significant decline of DDT residues in the lake by 1972. By 1973, DDT in bloaters, for

Figure 26

DDT Levels in U.S. Surface Waters, 1970-74



Source: Environmental Protection Agency, STORET.

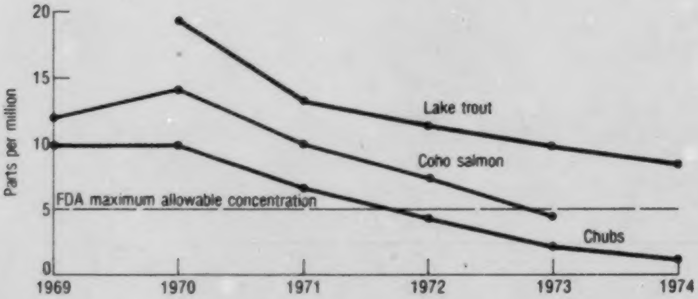
example, had declined to 1.33 parts per million, down from 9.9 parts per million in 1969. These marked downward trends are continuing, as Figure 27 shows. Only in large lake trout of Lake Michigan and in some areas of Lake Superior are DDT residues now above the levels that FDA allows.[48]

Marine Systems

Estuarine oysters and other mollusks provide further evidence of lower DDT levels. Mollusks generally concentrate these chemicals and thus serve as indicators of pollution levels in coastal waters. A national monitoring program has shown that chlorinated hydrocarbon residues in estuarine mollusks correlate directly with the application of these chemicals in adjacent river basins.[49] Over the 7 years 1965–72, DDT was the most commonly identified pesticide, occurring

Figure 27

DDT Residues in Lake Michigan Fish, 1969-74



Source: J.L. Hesse, Contaminants in Great Lakes Fish, Michigan Department of Natural Resources, staff report, June 1975, p. 12.

in 63 percent of all samples analyzed. However, the trend was downward.

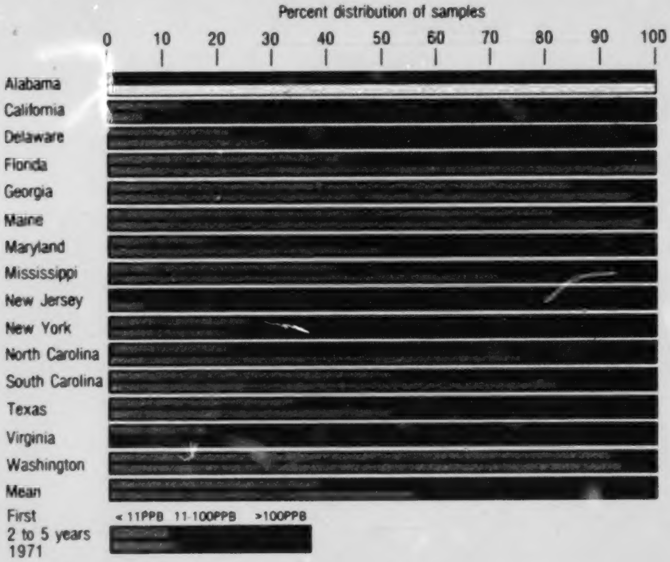
In 1971, the latest year that the data cover, DDT residues of more than 100 parts per billion were found far less frequently than in the first 2 to 5 years of monitoring, as Figure 28 shows. Samples showing 11–100 parts per billion of DDT dropped 20 percent, while mollusks with negligible or undetectable DDT residues increased 44 percent. In a sampling of North Carolina oysters, residues above 10 parts per billion dropped from 90 percent in 1967 to about 25 percent in 1971, as Figure 29 shows.

Analyses of menhaden, a commercially valuable estuarine fish sampled over a 2-year period off Port Harlingen, Texas, show a striking decline in residues between 1972 and 1974, as shown in Figure 30. There were fluctuations, possibly the result of weather conditions flushing DDT into estuaries at erratic intervals, but the trend was downward.[50]

Knowledge of how pollutants are diffused around the world is limited because there is no global monitoring system either for air or for water. Mean DDT concentrations of less than 1 part per trillion have been found in samplings of the surface waters of the North Atlantic taken from 1971 to 1974.[51]

Figure 28

DDT Residues in Estuarine Mollusks, 1965-71

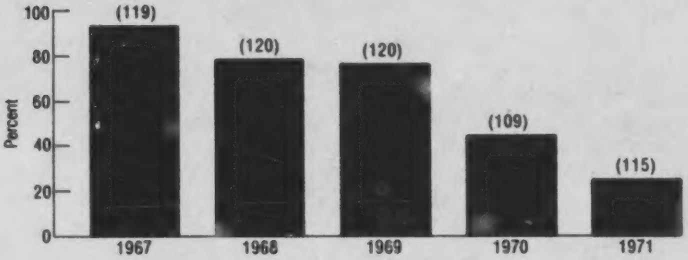


[1] Five percent over 1,000 in the first 2-5 years.

Source: P.A. Butler, "Organochlorine Residues in Estuarine Mollusks, 1965-72 – National Pesticide Monitoring Program," *Pesticides Monitoring Journal* VI (March 1973), p. 244.

Figure 29

Eastern Oyster Samples Containing More Than 10 Parts per Billion of DDT, 1967-71[1]



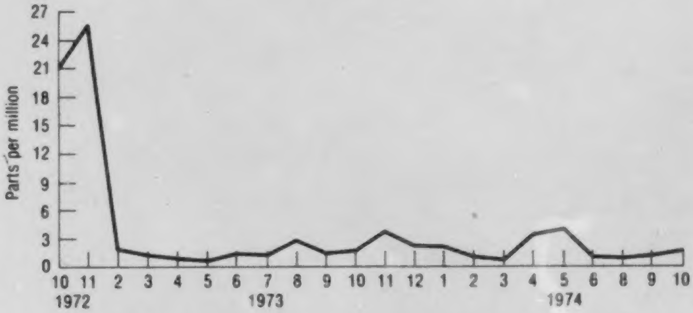
[1] Numbers in parentheses indicate the number of data points.

Source: P.A. Butler, "Organochlorine Residues in Estuarine Mollusks, 1965-72 – National Pesticide Monitoring Program," *Pesticides Monitoring Journal* 6(4), (March 1973), p. 245.

Data on DDT levels in deepwater fish are scarce. Herring samples taken off Nova Scotia and Newfoundland in 1968 and 1969 showed higher DDT levels than samples collected in 1972 and 1973. In spite of differences in the two studies' methods, the investigators concluded that DDT levels have in fact decreased.[52] Preliminary results from a monitoring program which EPA and the National Oceanic and Atmospheric Administration began in 1974 show widespread traces of DDT in ocean fish. The livers of some fish are found to contain residues of DDT well above 5 parts per million.[53] DDT concentrations up to 10 parts per million have been found in fish off the coast of California.[54]

Figure 30

DDT Residues in Menhaden, 1972-74



Source: Philip A. Butler, Project Officer, Gulf Breeze (Florida) Laboratory.

Although the levels of DDT in ocean water are generally low, chlorinated hydrocarbons are often biomagnified in the marine food chain to toxic levels. These chemicals, not very soluble in water but highly soluble in fat, are especially subject to bioaccumulation. As a result, even the generally low levels in ocean water may be bioaccumulated in the marine food chain to very high or even to toxic levels. Premature birth of California sea lions, for example, is associated with DDT levels in the mother's blubber as high as 1,039 parts per million.[55]

DDT in Humans

Human DDT intake and accumulation are a matter of prime concern. Most of the DDT that people ingest comes from dairy and meat products; in 1973, these two food groups accounted for 95 percent of the daily intake of DDT in the United States. Residues of DDT in both food groups have declined markedly since the mid-1960's, however, as Figure 31 shows.

The average daily intake of DDT, as calculated in the Food and Drug Administration's market basket program, has likewise dropped. The FDA program, which began in 1964, samples over 100 items of food from 30 cities and analyzes them for chemical residues after they are prepared for the table. During the 10 years of study, daily intake of DDT and its analogs has dropped from a maximum of 69.1 micrograms in 1965–66 to 6.14 micrograms by 1973–74.

The rapid decline in DDT use and intake is now being reflected in lower DDT levels, as directly measured in human tissue. Since the beginning of the National Human Monitoring Program in 1967, DDT residues have been found in 99+ percent of all human tissue samples; the figure in 1973 was 100 percent. The mean residue level has declined, however, from 7.87 parts per million in 1970 to 5.89 by 1973.

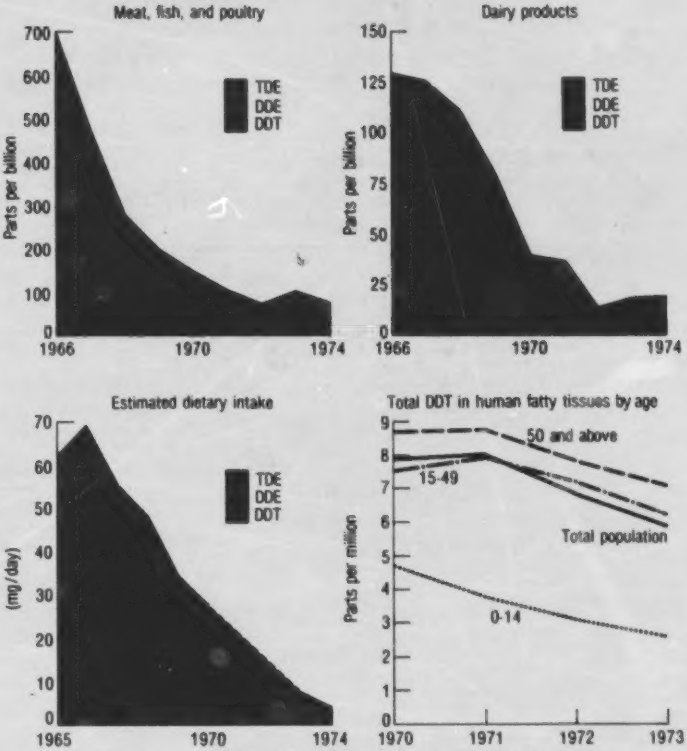
DDT residues in the youngest age group, children up to 14 years, are declining more consistently than those in older persons—an indication of the recent decline in intake. Of the residues formed, the parent compound DDT itself is found in decreasing proportion to one of its metabolites, DDE. DDE, which represented 77 percent of the DDT complex in human tissue in 1970, now comprises 81 percent. These findings suggest that increasingly, the DDT found in human tissues is due to persisting residues of the DDT that entered the environment years ago.[56]

Conclusions

Restrictions on DDT use have brought about significantly lower measured DDT levels in wildlife and in human food supplies. There has been a consistent but more gradual decline of DDT residues in human beings. Soils have shown, if not a decline, at least a stabilization of DDT levels. Restrictions on use, then, have substantially re-

Figure 31

Estimated Dietary Intake and Residues of DDT, Fiscal Years, 1965-74



Sources: Information supplied by the Environmental Protection Agency and the Federal Drug Administration; D.D. Manske and R.D. Johnson, "Pesticide Residues in Total Diet Samples (VIII)," *Pesticides Monitoring Journal*, in press; R.E. Duggan and P.E. Corneliussen, "Dietary Intake of Pesticide Chemicals in the United States (III), June 1968-April 1970," *Pesticides Monitoring Journal*, 5(4) (1972), pp. 331-41.

duced the environmental risk from DDT. Yet the persistence and ubiquity of this chemical make it certain that DDT will remain a matter of environmental concern for many years.

ALDRIN AND DIELDRIN

Aldrin and dieldrin, chlorinated hydrocarbons discovered in the 1940's, have been in commercial use as pesticides since 1950. The compounds differ somewhat in use, but because aldrin readily breaks down into dieldrin, we will not attempt to distinguish between the two.

Aldrin/dieldrin was intended as a broad-spectrum pesticide for a variety of uses, from controlling boll weevil to combating the housefly. Like DDT, aldrin/dieldrin is fat-soluble and degrades very slowly to biologically inactive products. Not surprisingly, widespread aldrin/dieldrin contamination of biological systems appeared in the late 1960's.

Concern about aldrin/dieldrin contamination was triggered by its lethal effects on fish. In 1955, when dieldrin was applied to 2,000 acres of salt marsh in St. Lucie County, Florida, in an effort to eradicate the sand fly, more than 1 million fish representing some 30 species were killed. In the next 4 weeks no reproduction among the remaining fish was observed.[57] Aldrin/dieldrin residues have also been correlated with reproductive failures in bald eagles and other birds.[58] More important, aldrin/dieldrin has induced malignancies in test animals. It is therefore presumed to be a human carcinogen.[59]

Federal Actions

In March 1971, EPA issued a notice of intent to cancel all federal registrations of products containing aldrin and dieldrin. This was the first step toward a ban on all use of the chemicals. Shell Chemical Company, the sole domestic manufacturer, shortly thereafter voluntarily withdrew a number of the more controversial uses, including aerial application, granules for termite dust formulations, and fire ant control.

In September 1974, citing imminent cancer hazard, EPA announced suspension of all but one of the remaining major uses of aldrin/dieldrin, including uses for control of soil insects attacking corn and citrus fruit, for orchard trunk spraying, and for foliage

Formulations of aldrin/dieldrin for aerial application are among the products voluntarily discontinued by the manufacturer since 1972.

application on certain fruits and vegetables. The only remaining use is for termite control. The manufacturer has announced that it will no longer produce aldrin/dieldrin for any use.

Commercial Flows

Even before the ban, the domestic use of aldrin/dieldrin had been generally declining, from a peak of over 21 million pounds in 1966 to about 10 million pounds in 1974, as Table 22 indicates. In 1975 aldrin/dieldrin use was about 273,000 pounds at most, primarily for termite control.

Terrestrial Systems

In 1969, dieldrin was the most common chlorinated hydrocarbon pesticide found in cropland soil samples. The National Soils Monitoring Program reported dieldrin residues at 28 percent of sample sites and aldrin at 11 percent. (By comparison, DDT was found at 26 percent of the sites.) The survey found average levels of 0.02 parts per million for aldrin and 0.03 parts per million for dieldrin where they were present in the soil samples.[60]

Preliminary data from the monitoring program for fiscal years 1970–73 suggest that aldrin/dieldrin residues are quite stable in soil. A soil half-life of 2 to 7 years has been reported for dieldrin.[61] In those areas of the Midwest where use was heavy through the 1960's, soil residue levels have not yet shown any significant decline and may not do so for several years.

Dieldrin residues in migratory songbirds, as monitored between 1964 and 1973, have generally been low; they averaged 0.27 parts per million throughout the period. No consistent trends were apparent: for 1964–66 the average was 0.51 parts per million; for 1969–70. 0.21 parts per million; and for 1973, 1.09 parts per million.[62]

On the other hand, lower dieldrin levels have been reported in starlings. A national program which monitors 1,300 starlings bi-

Table 22

Aldrin/Dieldrin Sales, 1965–74

Year	Volume (in pounds)	Year	Volume (in pounds)
1965	16,092	1970	9,658
1966	21,235	1971	12,320
1967	19,565	1972	12,608
1968	15,022	1973	10,576
1969	11,108	1974	[1]~10,000

[1] The symbol "~" means "approximately."

Source: Environmental Protection Agency, Consolidated Aldrin/Dieldrin Hearings, Recommended Decision of Chief Administrative Law Judge, 39 *Fed. Reg.* 37251 (1974).

ennially found that in 1967–68, dieldrin residues were below 0.1 parts per million in 65 out of 126 samples; in 1970, 98 out of 125 samples were below that level. Annual sales (shown in Table 22), with which residue levels in starlings are roughly correlated, indicate that dieldrin levels probably declined slightly in 1974 and dropped sharply in 1975.[63]

Air Systems

In 1971, extensive monitoring of ambient air in nine U.S. localities detected aldrin in only one sample at 8 nanograms per cubic meter. Dieldrin was found in several samples at one location, at a maximum concentration of 29.7 nanograms per cubic meter. Air monitoring conducted by EPA during 1970–72 detected dieldrin in over 85 percent of the 3,345 air samples taken nationally. From 1965 through 1973, dieldrin in rainwater, which collects pollutants from the air, ranged from 5 to 42 nanograms per liter.[64]

Freshwater Systems

Of 56 U.S. rivers surveyed in 1964, 44 were contaminated with chlorinated hydrocarbons in concentrations ranging from 0.002 to more than 0.118 parts per billion. Dieldrin was detected in 39 of the rivers.[65]

Because of difficulties with water quality data, analysis for aldrin/dieldrin trends does not yield statistically significant results. It appears, however, that aldrin/dieldrin levels in water correlate reliably with use of the chemicals. During 1970–74, usage remained relatively constant, and so did aldrin/dieldrin levels in water, according to the incomplete data so far available (see Figure 32).

In Lake Michigan, fish residues of the insecticides have regularly averaged just below the FDA allowable limit of 0.3 parts per million. There has not been a significant decline since the 1960's, as Figure 33 indicates.

Marine Systems

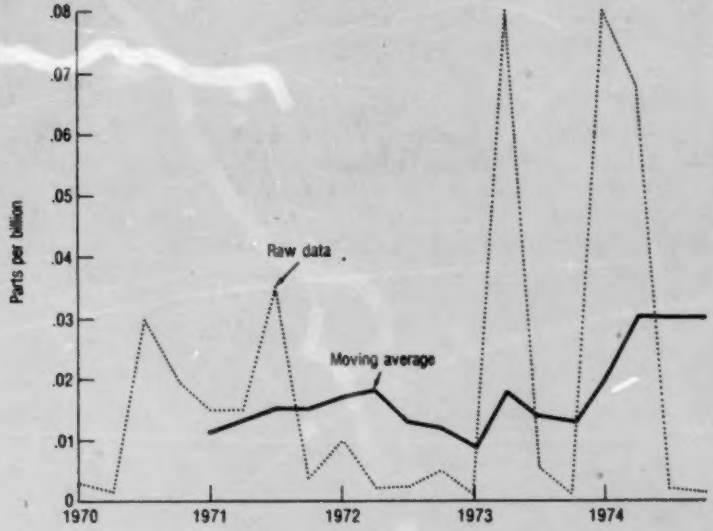
A national program that monitored estuarine mollusks for chlorinated hydrocarbons found DDT most frequently and dieldrin next. The maximum level was 0.23 parts per million in mollusk tissue. No general trend in aldrin/dieldrin residues was observed between 1965 and 1972.[66] Expected high levels of dieldrin were not found in a study of mollusks from San Francisco Bay, even though it is the drainage outlet for more than 6 million acres of farmland in the Sacramento and San Joaquin Valleys.[67] Dieldrin has not appeared as a problem in ocean fish.

Aldrin and Dieldrin in Humans

Because of evidence that aldrin/dieldrin is carcinogenic, human exposure levels are of great concern. Since 1965 the FDA has con-

Figure 32

Dieldrin Levels in U.S. Surface Waters, 1970-74

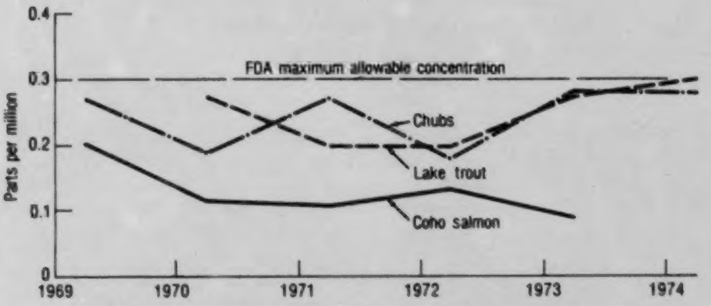


Source: Environmental Protection Agency, STORET.

ducted measurements of aldrin/dieldrin in its market basket project. The incidence of detectable aldrin, which is quickly degraded to dieldrin, has declined from 5.6 percent of all food samples in 1965 to virtually none since 1972. Incidence of dieldrin has increased, but the average dieldrin level declined, offsetting the increase, so that

Figure 33

Dieldrin Residues in Lake Michigan Fish, 1969-74



Source: J.L. Hesse, Contaminants in Great Lakes Fish, Michigan Department of Natural Resources, staff report, June 1975, p. 14.

net daily intake has declined. Most of the recent decline in intake is correlated with diminishing residues in potatoes, cereals, and grains to which the pesticide had previously been applied; the levels in dairy products and meat, fish, and poultry have remained constant.

On the basis of the market basket surveys, FDA has also calculated the dietary intake of aldrin/dieldrin year by year through 1974. Figure 34 compares sales with intake, calculated on the basis of milligram per kilogram of body weight per day. The data suggest that aldrin/dieldrin intake declined slightly a year or two after sales dropped.

Very little data on aldrin/dieldrin residues in human tissue are available for the years before 1967, and major changes in analytical techniques make comparisons with years before then questionable. Human residue data provided by the EPA Human Monitoring Program since 1970 are self-consistent and reliable. Like DDT, dieldrin is found in almost every human tissue sample collected. The incidence was about 99 percent in 1973, and the samples contained dieldrin at an average concentration of 0.18 parts per million. The frequencies and levels of dieldrin have not changed appreciably during the 4 years 1970–73, even in the youngest age group.[68]

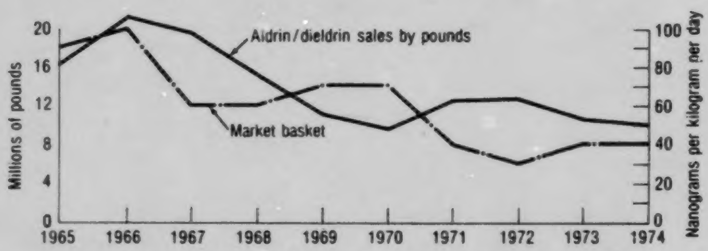
Conclusions

Data on aldrin/dieldrin are more sparse than for DDT. Further, there was no significant decline in the use of these chemicals between 1969 and 1974. For these reasons, it is difficult to correlate patterns of use with environmental levels.

Because there are no data available for the period since September 1974, when most aldrin/dieldrin uses were banned, the effects of the ban cannot yet be assessed. Within a few years we should be

Figure 34

Aldrin/Dieldrin Domestic Sales and Dietary Intake, 1965-74



Source: Environmental Protection Agency Consolidated Aldrin/Dieldrin Hearings, Recommended Decision of Chief Administrative Law Judge, 39 *Fed. Reg.* 37251 (1974); R. Duggan et al., "Pesticide Residue Levels in Foods in the United States from July 1963 to June 1969," *Pesticides Monitoring Journal* V (September 1971), p. 80; R. Duggan, Consolidated Hearings, April 25, 1974, Exhibit 34; M. Fischer, Consolidated Hearings, September 4, 1974, Exhibit 7; Food and Drug Administration, unpublished information.

able to estimate the rate of decline of this persistent pesticide in various environmental systems. Current evidence seems to indicate that levels of dietary intake will decline fairly rapidly as direct application to foodstuffs stops.

PCB's

Polychlorinated biphenyls, a class of synthetic chemicals that have no naturally occurring counterpart, have been widely used since the 1930's. Discovery in 1971 that they were widely dispersed throughout the environment and had accumulated to toxic levels in wildlife prompted efforts to assess and control their environmental impacts.

Because PCB's are chemically inert, they are ideally suited for certain industrial applications. They are relatively insoluble in water, are resistant to acids, alkalies, and corrosive chemicals, are stable to prolonged heating, and are believed more resistant to biodegradation than DDT. Because of these properties, PCB's have been valued as coolants and insulators for such heavy electrical equipment as transformers and capacitors. Until 1971, these two uses accounted for slightly over half of total production. Other uses, ranging from fire-resistant hydraulic fluids and lubricants to surface coatings, inks, adhesives, pesticide extenders, and microencapsulation of dyes for carbonless duplication paper, accounted for the remaining 40 percent.

The acute toxicity of PCB's is low, and incidents of human exposure to high levels of PCB's have been rare, occurring mostly through occupational exposure or accidental contamination of food. It is the wide distribution of low levels of PCB's that is now of concern. Because the products of PCB breakdown have not been identified, the lifetime of PCB's in the environment and their ultimate fate are as yet unknown.

PCB's threat to wildlife was first discovered in 1966 when residues were detected in fish from the Baltic Sea. Then a disconcerting degree of bioaccumulation was found in many other organisms. In two simple food chains, fish and freshwater mussels contained fractions of one-tenth parts per million of PCB's. But these low levels were magnified to much higher levels in animals that eat fish and mussels. PCB's appeared at 5 to 21 parts per million in seal blubber and up to 240 parts per million in the muscle of the white-tailed eagle.[69]

Some aquatic species suffer toxic effects at very low exposure levels. Water containing PCB's at 0.1 parts per million was fatal to juvenile pink shrimp after a 48-hour exposure.[70]

PCB's have also been correlated with lethal effects in game birds;[71] with reduced reproductive capacity of fish-eating mammals, mink and seals; and with reduced resistance to viral infections in experimental animals.[72] A recent study indicates that PCB's may also be carcinogenic.[73]

In laboratory tests, PCB's at a concentration of 0.1 parts per million in water were fatal to juvenile pink shrimp after a 48-hour exposure.

Some uses of PCB's have led to low-level contamination of food products—pesticide formulations, bonding paper and cardboard for food packaging, and recycling for cardboard manufacture.

Federal Actions

A federal interagency task force, created by the Council on Environmental Quality and the Office of Science and Technology to coordinate the federal scientific effort, concluded in May 1972 that PCB contamination was ubiquitous, that it represented an unquantified but indisputable hazard, and that all nonessential uses of the substances should be discontinued.

In the absence of broad federal authority to restrict the use of PCB's, such as the proposed Toxic Substances Control Act, the only U.S. producer, the Monsanto Industrial Chemicals Co., voluntarily limited PCB sales to use in closed-system capacitors and transformers. Because PCB accumulation in fish and aquatic invertebrates could reach levels thousands of times higher than that in the ambient water, EPA recommended revising water quality standards to reduce PCB levels in lakes and rivers below 0.01 parts per billion.

In 1973, the Food and Drug Administration adopted stringent limits for PCB's in food and food packaging and issued regulations designed to prevent accidental contamination of foods in food plants.[74] In February 1973, the Organization for Economic Cooperation and Development, which consists of Japan, Australia, and nations of Western Europe and North America, adopted a directive limiting worldwide use of PCB's. Member countries agreed to restrict use to transformers, capacitors, heat transfer fluids, and hydraulic fluids for mining equipment and to control the manufacture, import, and export of products containing PCB's.

In August 1975, as a result of discoveries of continuing high levels of PCB's, EPA reinforced its efforts to identify uses, distribution, and effluent levels. EPA has also accelerated its timetable for developing a national effluent standard pursuant to section 307(a) of the Federal Water Pollution Control Act.[78] Other activities scheduled for the near future include publication of final water quality criteria and proposals for regulations governing liability in spills involving PCB's.

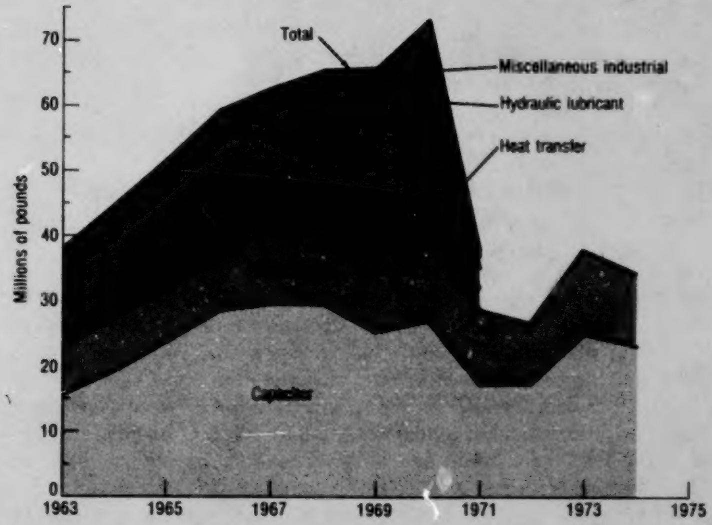
Commercial Flows

Rapid expansion of PCB use began in 1945. Annual domestic production and sales doubled between 1960 and 1970, with production exceeding 85 million pounds in 1970; 1971 production plummeted to 35 million pounds; 1974 domestic production was 40.5 million pounds. Domestic sales are shown in Figure 35. No data on PCB imports were collected before 1971, but in the last 4 years there were small imports of PCB's on the order of 378,000 pounds per year. Slightly more than 1 percent of total domestic use, this amount would add little to environmental levels if used solely in closed systems.

It has been estimated that 16.7 million pounds of PCB's was released into the North American environment in 1974 (see Table 23).

Figure 35

Domestic Sales of PCB's by Category, 1963-74



Source: Monsanto Industrial Chemicals Co.

Table 23

Estimated PCB Input Rates, North America, 1970 and 1974

(In millions of pounds)

	1970	1974
Vaporization of plasticizers	3.30	Negligible
Vaporization during open burning	0.88	[1] 0.38
Leaks and disposal of industrial fluids	9.90	[2] 0.99
Disposal in dumps and landfills	39.60	15.40
Total	53.68	16.72

[1] Assuming 20 percent annual decrease in PCB's reaching open burning.

[2] Assumed to have decreased an order of magnitude, partially due to collection by Monsanto and partially due to greater awareness and many fewer firms handling the material.

Source: David P. Peakall, "PCB's and Their Environmental Effects," *CRC Critical Environment Review* (in press).

The sources were varied. In the Michigan area, a survey of 39 industries confirmed that PCB's are still used in at least 20 different products, not all of them closed systems. A company in Chicago, for example, produces wax containing PCB's. It appears that many industries have a stockpile that will last for some time. Other industries may be using PCB-containing products unaware, for example, in recycled contaminated paper.

A probable major source of continuing PCB release to the environment is improper waste disposal. Temperatures of 2000° F are required to destroy PCB's. Monsanto successfully destroyed 7.48 million pounds of spent fluid in 1973–74.[76] It appears that the cost (5 cents per pound, $8 per drum service charge, plus shipping expenses) discourages users from returning the used PCB-containing fluid to the Monsanto facility.

Surveys indicate that many industries add PCB's to waste oils and dispose of them through waste haulers. Sometimes waste PCB's are used as fluids for dust control in parking lots. Or they may be stored in drums on plant property and later burned in unapproved incinerators and boilers or buried in landfills.[77]

Terrestrial Systems

Because PCB's were once used in some pesticides but have generally not been applied directly to soil, they are not monitored routinely in the National Soils Monitoring Program. The compounds generally enter the terrestrial environment in other ways, by disposal in landfills, as sewage sludge deposited on land, through incineration, or by vaporization from paints, coatings, and plastics.

PCB's are known to accumulate in terrestrial birds. The national program to monitor residues in starlings discussed in the section on

DDT reported low levels of PCB's, generally below 1 part per million in all but 3 of the sites sampled in 1972. Excessive levels at one site—24.3 parts per million in 1970 and 19.9 parts per million in 1972—remain unexplained. Further monitoring is planned for this site to try to identify the sources of contamination.

PCB's have also been measured in woodcocks from the northern United States in concentrations of 4–9 parts per million. Bald eagles collected from 25 states have shown contamination.[78]

Air Systems

Levels of PCB's in ambient air, away from direct sources of discharge, are low, a few parts per trillion. Total PCB releases to the atmosphere in North America in 1970 were estimated at 3.3–4.4 million pounds. Because the major source, vaporization from plastic materials, has been removed, it is likely that this input has now decreased by an order of magnitude.[79]

Although the time that PCB's remain suspended in the air may be short, the atmosphere appears to be a significant means of transport. This is perhaps the best explanation of residues found in Arctic lakes.[80]

Freshwater Systems

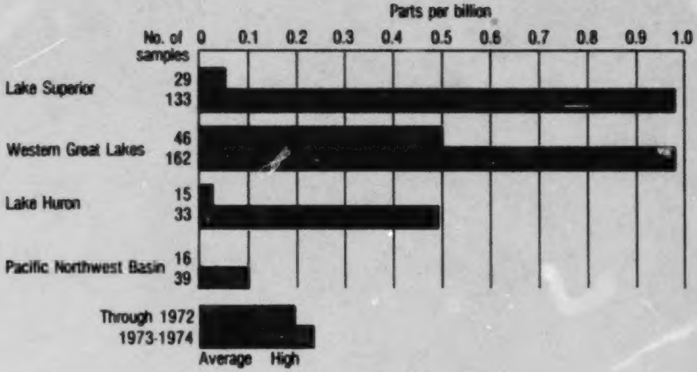
Fresh water is an important repository and transport mechanism for PCB's. Use patterns and measurements in industrial outfalls, receiving waters, downstream waterways, and fish demonstrate that this statement is true. Likely sources of continuing releases to fresh waters are PCB wastes leached from landfills and deposits of airborne residues.

Because awareness of the PCB problem is so recent, water quality data are still too sparse for indicating trends. The raw data presented in Figure 36 on PCB levels in various waterbodies are not corrected for variations in measuring station locations, dates, and so forth. They cannot be assumed to have statistical significance, but they can at least provide a baseline for future reports. These incomplete data indicate that measured concentrations of PCB's through 1972 may be below the average measured in 1973–74.

Data for Great Lakes fish have been collected since 1972. Because declines of DDT and mercury levels have been observed following control programs, investigators expected that PCB contamination levels would also begin to decline by now. Yet the sparse data collected so far show a disconcerting pattern of static or rising PCB levels; they are shown in Figure 37. Several Lake Michigan fish shipments were seized by FDA this year because PCB residues in chubs, coho salmon, and lake trout exceeded the current guideline of 5 parts per million by as much as a factor of 33. Similar elevated levels have been found in Lake Superior trout.[81] In August this year, the New York State Environmental Conservation Commissioner reported that some species of fish in the Hudson River were also exceeding the

Figure 36

PCB Levels in Fresh Water



Source: Environmental Protection Agency, STORET.

FDA tolerance of 5 parts per million; concentrations as high as 350 parts per million appeared in one sample of rock bass.[82]

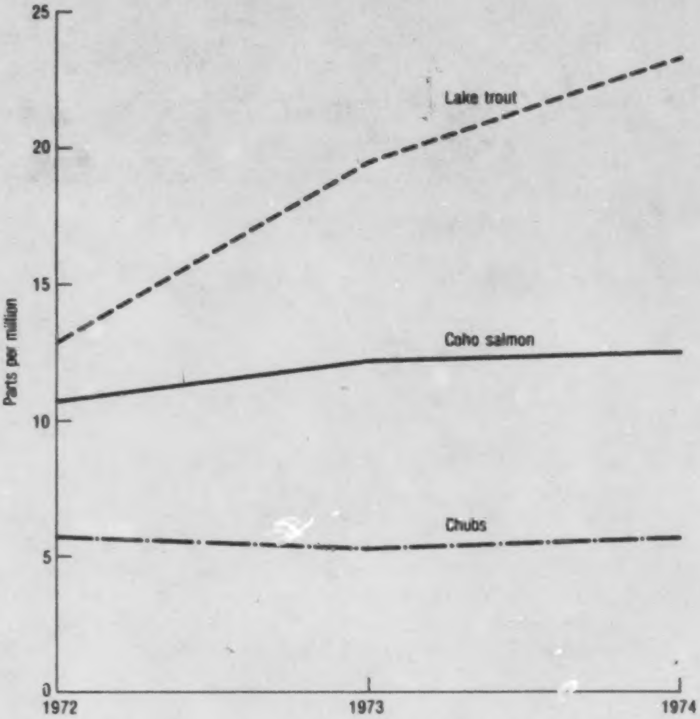
Elimination of PCB sources had led to rapid reduction of PCB residues in fish in the Saginaw River. In 1971–72, the Saginaw had the highest PCB concentrations of any Great Lake tributary within Michigan boundaries. The average concentration in the water was 1.1 parts per billion, the EPA recommended maximum is 0.01 parts per billion, and concentrations as high as 165 parts per million were recorded in the fish. Sixty major sources of the pollutant had average effluent concentrations of 0.56 parts per billion. One source, a waste water treatment plant, was releasing effluent with a concentration of 120 parts per billion. Industrial sources converted to substitutes and by October 1972, concentrations in the river water were nearly undetectable. Shortly thereafter, residues measured in fish declined markedly.[83] In 1972, gizzard shad had average levels of nearly 100 parts per million, carp about 30, and pike slightly over 10. By August 1973, concentrations in all species tested were below 5 parts per million. Although it is reasonable to expect a river to be purged faster than a body of water the size of Lake Michigan, this explanation does not seem adequate for the vast discrepancy between the Saginaw River and the Great Lakes.

Marine Systems

The total input of PCB's into the oceans of North America has been calculated at about 3.3 million pounds and for DDT at about 110 million pounds.[84] Yet samplings in the North Atlantic indicate that PCB residue levels in the water are at least as high as those of

Figure 37

PCB Residues in Lake Michigan Fish, 1972-74



Source: J.L. Hesse, Contaminants in Great Lakes Fish, Michigan Department of Natural Resources, staff report, June 1975, p. 15.

DDT, despite the much greater load of DDT discharges. The implication is that PCB's are even more persistent in ocean water than long-lasting DDT.

Another anomaly is that samplings taken at different times showed extreme variations in PCB levels. In eight samplings of North Atlantic surface waters taken between 1971 and 1974, PCB residues ranged from 41 parts per trillion in 1972 to 0.8 parts per trillion in 1974. DDT levels were consistently less than 1 part per trillion in all samples. Some levels are listed in Table 24.

Sediments deposited off the Santa Barbara coast showed increasing PCB levels for a number of years, through the most recent sampling in 1967.[85] Studies of more recent inputs to the area reveal that PCB's are still a major problem—they are being discharged at a rate of 12,100 pounds per year. Most of this pollution originates with

Studies conducted by EPA and the New York State Department of Environmental Conservation have confirmed severe contamination of Hudson River fish by PCB's discharged from industrial sources. Here water samples are taken in New York Harbor.

municipal waste water. A comparison of rates for DDT and PCB's shows that PCB inputs now exceed DDT by 3½ times (DDT emissions are down 90 percent from 1971 levels). PCB residues in intertidal mussels, which respond quickly to changes in ambient levels, declined only about one-third from the 1971 level, reflecting the continued input of the chemicals into the coastal waters.[86]

In 1972 a study found that most Atlantic coast fish had PCB residues of 0.2–0.5 parts per million.[87] Most of the fish samples collected by an EPA–NOAA monitoring program in 1974 also contained PCB's, with higher levels occurring in the Northwest Atlantic.[88] An-

Table 24

PCB and DDT Concentrations in North Atlantic Surface Waters, 1971–74

(In parts per million)

Date	Mean PCB	Mean DDT[1]	Area
August 1971	25	NS	Iceland–Newfoundland
July 1972	41	<1	Newfoundland–Portugal
August 1972	36	<1	Portugal–Norwegian Sea
September 1972	30	<1	Massachusetts–Bermuda
April 1973	1	<0.15	Sargasso Sea
September 1973	2	<1	Azores to Barbados
September 1973	0.8	NS	Sargasso Sea–New York
February 1974	0.8	NS	New England continental shelf

[1] NS=Not significant.

Source: David B. Peakall, "PCB's and Their Environmental Effects," *CRC Critical Environment Review* (in press).

other survey comparing chemical residues in herring taken off Newfoundland in 1972–73 with herring samples from 1968–69 showed that PCB levels remained constant while DDT levels decreased.

PCB's in Humans

In 1971, the accidental contamination of poultry feed with PCB's forced the slaughter of thousands of chickens and turkeys. No such incidents have occurred since the FDA strictly limited PCB use in 1973. In 1974, only 7 of nearly 4,000 meat and poultry samples analyzed by the USDA contained detectable quantities of PCB's.

FDA market basket surveys show that in 1971 PCB's were present in 5 percent of the 360 composite foods analyzed; all 18 occurrences were in meat, fish, and poultry or in grain products. Three-quarters of the occurrences were at trace levels—that is, at the limit of detection capability. PCB levels ranged as high as 0.36 parts per million. The following year PCB's were detected in 43 samples (12 percent of the total) and in 9 of the 11 food categories. Ninety percent of these occurrences were at trace levels. Average levels in meat, fish, and poultry had declined, and the highest level detected had dropped to 0.15 parts per million.

In 1973 and 1974, PCB residues in food declined both in amounts and in incidence. In 1974 PCB's were detected in 14 (less than 4 percent) of all the composite foods. Thirteen of the occurrences were in meat, fish, and poultry. The highest residue level detected was 0.05 parts per million and that was the only sample showing contamination above the trace level. Dietary intake, estimated at 0.1 micrograms per kilogram of body weight per day in 1971 dropped to 0.02 in 1973 and 0.001 in 1974.

In 1972 the National Human Monitoring Program detected PCB's in almost 75 percent of the samples, most of them in the 1–3 parts per million concentration range. An average concentration for DDT was about 7 parts per million in the same year. The health implications of these data are not known, nor is it possible at this time to predict how rapidly levels in human tissue may decline.

Conclusions

Unlike pesticides, PCB's are not deliberately released to the environment. But they are chemically related to such pesticides as DDT and dieldrin, and they appear to cycle and accumulate in a very similar manner. PCB's were recognized as a problem so recently that the monitoring data collected in the few years since 1970 give only a crude idea of what to expect in the future. How they behave in the environment—how they are degraded, for example, or how they are transported—is still uncertain. Efforts to eliminate release of PCB's to the environment have not been entirely successful.

PCB residue levels in most foodstuffs have dropped, but in some environmental systems and wildlife they have shown little decline. Although domestic PCB production has been halved by the voluntary action of the manufacturer and cooperating industries, uses that disperse these persistent materials widely and inadequate methods of disposal continue. Further restrictions on the use of PCB's may be necessary before environmental levels as a whole will stabilize and decline.

MERCURY

Mercury is a naturally occurring substance. Although it is not abundant, it is widely distributed throughout the environment. Estimates for natural background levels in ocean water, for example, range from 0.03 to 2.0 parts per billion.[89]

An unusual combination of physiochemical properties—liquidity at room temperatures, uniform volume expansion, good electrical conductivity, high density, high surface tension, and an ability to form amalgams with almost all common metals—makes mercury suitable for a host of applications in dozens of industries.[90]

Once loosed from stable mineral deposits, mercury is extremely mobile, circulating in various forms through air, water, soil, and inevitably, living things. Evidence of man's redistribution of the earth's free mercury is recorded in the mercury content of glacial ice. Analyses of samples dating back to 800 B.C. from Greenland and Antarctica show a 240 percent increase in concentration since about 1952. Samples from water deposited before 1952 had mercury contents ranging from 30 to 75 parts per trillion, with an average value of 60±17 parts per trillion, compared to a range of 87–230 parts per trillion and an average of 125±52 parts per trillion between 1952 and 1965. The increase reflects not only commercial use of mercury but also the release of mercury by other means, fossil fuel combustion, for example.[91]

The toxic properties of mercury were known to Hippocrates over 2,000 years ago. Mercury became a significant occupational hazard in the mid-19th century, when the synthesis of organic compounds led to hundreds of new uses.

Several large-scale outbreaks of mercury poisoning in the 1950's and 1960's made it clear that the dangers of mercury go beyond occupational hazards. Beginning in 1953, at least 121 people in Minamata, Japan, suffered severe nerve disorders, brain damage, birth defects, and death, all due to mercury poisoning although the cause was not discovered until 1959. Seafood contaminated by methyl mercury discharges from plants manufacturing vinyl chloride and acetaldehyde had poisoned the victims. Forty-nine more cases were reported in Niigata, Japan, between 1965 and 1970.[92]

Animals are also susceptible to mercury poisoning. In the 1960's, the populations of several bird species in Sweden declined, concomitant with use of mercury-disinfected seeds. Corroborative evidence came from several experiments with pheasants and chickens in which residue levels comparable to those found in wild birds increased mortality among adult birds, reduced egg-laying, and lowered embryo survival.[93] Mercury poisoning has been observed in aquatic species up the entire food chain. Exposure to methylmercury compounds at 60 parts per billion is lethal to marine phytoplankton, and exposure to as little as 0.1 parts per billion measurably reduces photosynthesis and growth.[94] Mercury exposure is also correlated with increased mortality and harmful effects on growth and reproduction in several fish species.

Synthetic chemicals like DDT and aldrin/dieldrin ultimately lose their toxicity when they are degraded into the simpler elements that compose them, although the process of degradation is slow. Mercury is a naturally occurring element and cannot be degraded in the same way. Its toxicity is integral. When mercury combines with other substances, for example, when bacterial action converts it to methylmercury, the resulting compounds are even more toxic than mercury alone. The only ways to render mercury harmless are to remove it from the environment or to stabilize it permanently by physical or chemical means so that it is inaccessible to biological processes.

It was discovered a few years ago that inorganic mercury deposited in sediments can be transformed into methylmercury by aquatic organisms. When methylated, mercury becomes extremely toxic and it is readily released from sediments into water. Natural processes, then, may recycle hazardous concentrations of mercury through the food web.[95]

Federal Actions

Beginning in 1969, the federal government took steps to reduce environmental and human exposure to mercury. The Department of

Agriculture and later EPA suspended most seed treatments, and FDA set a 0.5 parts per million mercury tolerance in fish. Because mercury is readily absorbed through the skin, FDA also banned its use in cosmetics.[96] By late 1971, EPA had suspended mercurial fungicides and slimicides for use in swimming pools, cooling towers, and laundering and issued a notice of intent to cancel all other uses of mercury compounds as biocides. Cancellation hearings on uses in paints and in fungicides for golf courses and other turf and for several minor uses are continuing.

In 1970, under the permit authority of the Refuse Act of 1899,[97] major mercury dischargers were requested immediately to reduce effluents to water to less than one-half pound per day. They were also asked to report periodically on further plans to meet a goal of less than one-fifth pound per day. The permit program identified 50 companies as mercury dischargers, 10 of which were formally charged by the Justice Department with polluting the nation's waterways. Federal, state, and industry actions reportedly reduced total discharges to water from 287 pounds per day in July 1970 to about 40 pounds in September. By 1971, 9 of the 10 facilities prosecuted were operating under interim stipulations and were discharging one-half pound per day or less; the tenth plant was shut down. The total discharge from three of these facilities dropped from 139 pounds per day to 2 pounds. Pending promulgation of national effluent standards for toxic pollutants (under section 307 of the Federal Water Pollution Control Act[98]), effluents are now subject to permit requirements administered by EPA or to regulation by the states. Almost all firms are now reporting compliance with permit requirements. Standards governing emissions to the air from chlor-alkali and mercury ore processing plants have also been in effect since July 1973.[99]

Commercial Flows

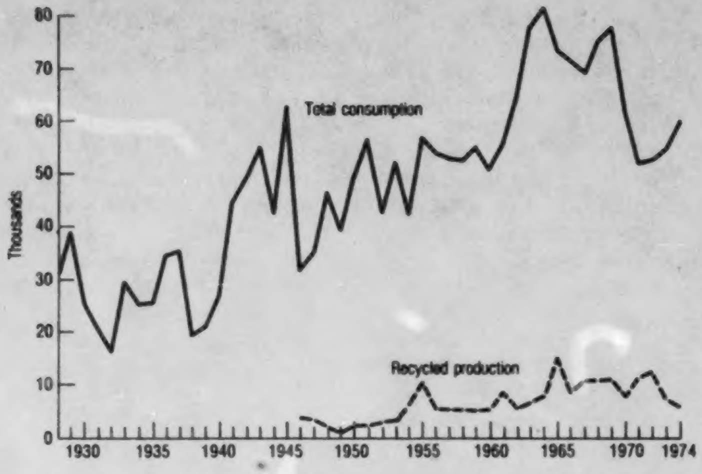
With restriction on use, total U.S. mercury consumption dropped from 77,372 flasks in 1969 to 52,257 flasks in 1971. The 59,479 flasks consumed in 1974 is well below the forecasts of 83,500 flasks for 1974–75 made in 1969.[100]

Curtailment of certain uses and substitutions for others have helped to dampen demand for mercury. Agricultural use of mercurials has declined from a peak of 7,500 flasks in 1955–59 to 980 in 1974. Mercury for paper and pulp manufacture and industrial amalgamations (metal alloys) has been eliminated. Uses in antifouling agents for paints and other substances have been sharply curtailed. Diaphragm cells have substituted in part for mercury cells in the chlor-alkali industry. After an initial sharp decline, however, mercury use in this industry has returned to about 81 percent of that in 1969, shown in Figure 38.

Commercial recycling of mercury—about 10 percent of total consumption in 1974—has not increased its share of the market. Inhouse recycling of mercury wastes would also help to reduce overall con-

Figure 38

Domestic Mercury Consumption, 1928-74



	1961	1965	1969	1970	1974
Agriculture (includes fungicides and bactericides for industrial purposes)	2,557	3,116	2,689	1,811	980
Amalgamation	278	268	195	219	–
Catalysts	707	924	2,958	2,238	1,298
Dental preparations[1]	2,154	1,619	2,880	2,286	3,024
Electrical apparatus[1]	10,255	13,931	18,490	18,952	18,678
Electrolytic preparation of chlorine and caustic soda	6,056	8,753	20,720	15,011	16,897
General laboratory use	1,484	1,119	1,936	1,806	476
Industrial and control instruments[1]	5,627	4,828	6,865	4,832	6,202
Paint					
Antifouling	915	255	244	198	6
Mildew proofing	5,146	7,534	9,486	10,149	6,807
Paper and pulp manufacture	3,094	619	568	226	–[2]
Pharmaceuticals	2,515	3,261	712	690	597
Redistilled[1]	9,013	12,131	–	–	–
Other[3]	5,962	15,402	9,849	6,085	3,514
Total	55,763	73,560	77,372	61,503	59,479

[1] In 1969-74 figures, the "redistilled" category is broken down and included in the categories for which the redistilled mercury was used.

[2] Included in the "other" category.

[3] Includes mercury used in installation and expansion of chlorine and caustic soda plants.

Source: V.A. Cammarota, Jr., "Mercury," in *Minerals Yearbook 1972*, U.S. Department of the Interior, Bureau of Mines, (Washington, D.C.: Government Printing Office, 1974), p. 775; National Materials Advisory Board, *Trends in Usage of Mercury* (Washington, D.C.: National Academy of Sciences, 1969), p. 9; H.J. Drake, "Mercury in the Second Quarter, 1975," Mineral Industry Surveys (Washington, D.C.: U.S. Department of the Interior, 1975), Table 6, p. 4.

sumption, but its extent is not known. However, it appears that most wastes are sent to landfills or holding ponds instead of being processed for mercury recovery.

Despite curtailment or cessation of certain uses, mercury consumption rose rapidly between 1971 and 1974—4.8 percent per year. Uses for electrical apparatus and the expanding chlor-alkali industry are chiefly responsible for bringing total consumption back to the 1960–64 level.

Terrestrial Systems

Every sample of rock and soil tested for mercury in the United States has detectable levels. Fallout of airborne mercury, disposal of contaminated solid wastes, and direct application of mercurial biocides or treated seed add to natural background levels and are among the principal sources of contamination on the land.

Mercury accumulates in plant tissue from soil; for example, as much as 2 parts per million has been found in white birch growing on mercury-rich outcroppings.[101]

Seed-eating birds demonstrate the impact of society's uses of mercury on the terrestrial food chain. Pheasants from the state of Washington, for example, showed a significant decrease in the average mercury content of their livers between 1969 and 1972.[102] Investigators attributed the change to less use of mercury-treated seed.

Air Systems

Little is known about the volume and means of mercury transport in the air. Concentrations vary considerably from place to place, from a low of 0.6 nanograms per cubic meter off the Pacific coast to 20,000 nanograms per cubic meter over mercury mines. Generally low levels over the oceans suggest that land sources, not excluding natural sources, are primarily responsible for mercury in the atmosphere.

Myriad processes inadvertently release mercury to the air. An estimated 6.6 million pounds of mercury is released annually through the burning of coal.[103] Wood contains 0.5–3.5 parts per million of mercury, which is released to the environment either by burning or by processing wood products. Refuse incinerators in Missouri and Illinois have been reported to emit 100–1,000 nanograms per cubic meter of mercury in stack discharges.

All locations where mercury is processed or used may discharge vapors into the air—sometimes intentionally, as when mercury is vented to the ambient air to comply with occupational health standards.

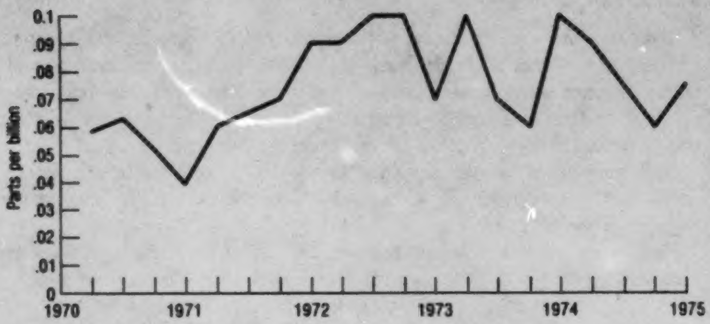
Freshwater Systems

In the short time since mercury has been recognized as a widespread hazard, not enough data have been gathered to permit the discovery of general trends, if indeed they exist. But there is evidence that the natural recycling of mercury is a long-term legacy of trouble from uncontrolled discharges in the past.

Nationally, levels of mercury in freshwater appear unchanged since 1970, as indicated in Figure 39, but the experiences of selected areas are divergent. High levels of mercury contamination in fish of the Tennessee Valley Authority reservoirs were reported in 1970.

Figure 39

Mercury Levels in U.S. Surface Waters, 1970-74



Source: Environmental Protection Agency, STORET.

The level dropped significantly shortly after direct mercury discharges into those waters were eliminated later in the year; yet since 1972, mercury levels in fish from TVA reservoirs have risen again, generally to levels above the FDA limit of 0.5 parts per million. Data for several years are shown in Figure 40.

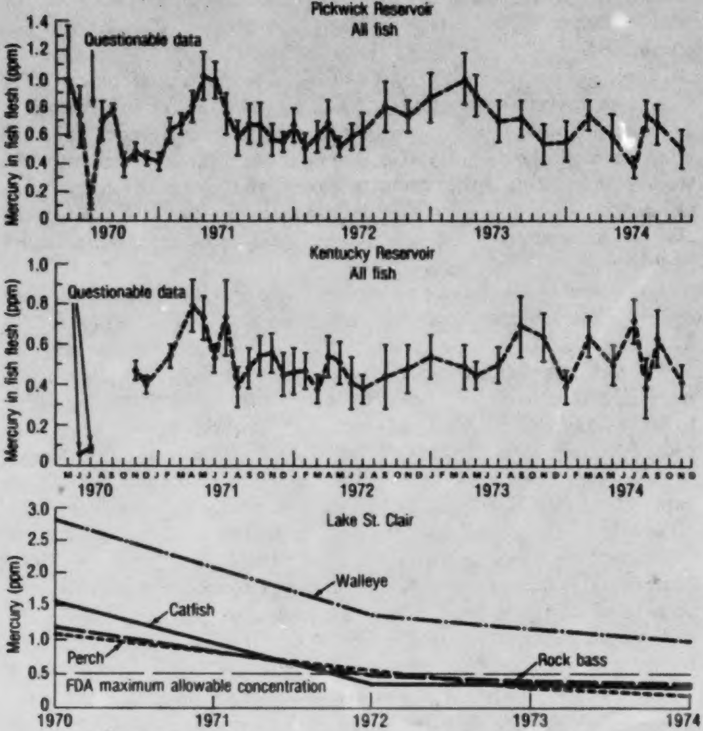
The mercury situation in one of these TVA reservoirs, Kentucky Lake, is described in detail in an EPA report to the Justice Department.[104] Background levels of mercury sediments in the study area were less than 0.1 parts per million, but sediments in the lake contained mercury concentrations up to 1.6 parts per million. Most of the mercury in the lake has been traced to discharges from chlor-alkali plants on the Tennessee River upstream; an additional mercury load came from a plant downstream via aerial transport.

Deposits of 2 inches of mercury-free sediments are required for effectively sealing the mercury from overlying water and its aquatic life.[105] Given TVA calculations that the silting rate around Kentucky Dam is on the order of 0.2 inches per year, an accumulation of 2 inches of sediments in Kentucky Lake will take 10 years. With July 1970 as time zero, at best it would be July 1980 before mercury-laden bottom sediment could be sealed. However, the sediments now being laid are still not mercury free. July 1980 is the earliest time that the mercury accumulation in fish may begin to dissipate.

A similar experience in Onondaga Lake has been reported by the New York State Department of Environmental Conservation. Onondaga Lake has a history of mercury contamination dating back 75 years to a chlor-alkali plant located in Solvay. In 1970, fishing was banned in the lake because mercury levels in the fish were well above 0.5 parts per million. That same year the chlor-alkali plant reported reduced mercury discharges from 4.4 pounds per day to about 0.5 pounds. The fish have been monitored for mercury since, and there

Figure 40

Mercury Residues in Freshwater Fish, 1970-74



Source: Tennessee Valley Authority; J.L. Hesse, Contaminants in Great Lakes Fish, Michigan Department of Natural Resources, staff report, June 1975, p. 13.

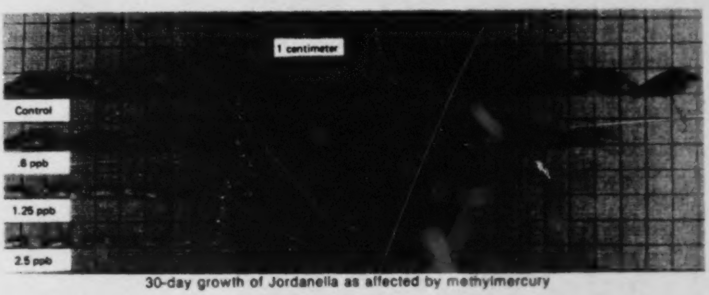
is no significant change in mercury levels in legal size (10-inch) sport fish. A partial explanation is that even when fish are removed from contaminated water and placed in holding ponds, residues in individual fish do not drop rapidly.[106] Decreases in concentration occur only as the size of the fish increases. A small decrease in concentrations may be detected in fish of legal size only when the fish spawned since 1970 have grown to the legal limit. It also appears that the mercury in the lake's sediment is continually recycling. Thus it may be many years before the fish in this lake are edible. Understanding is further complicated by the fact that mercury levels in fish from two nearby unpolluted lakes, Cranberry Lake and Stillwater Reservoir, are comparable to those in Onondaga Lake fish. The levels of mercury in fish from the two lakes are thought to be from natural sources. The problem is being studied further.

By contrast, in several other areas, levels of mercury in aquatic species have declined significantly a few years after mercury discharges to the water were controlled. For example, in Lake St. Clair, between Lake Huron and Lake Erie, a decline in mercury residue levels was reported shortly after sources of discharge were eliminated.[107]

Mercury contamination of Lake St. Clair was first reported by Canadian investigators in early 1970. Concentrations exceeding the FDA guideline were subsequently found in at least one species of fish from each of the Great Lakes. From these data, supplemented by studies of museum fish, it was apparent that naturally high background levels of mercury were common to the Great Lakes region and the effluent from a few manmade sources was enough to cause problems.

The sources of mercury pollution of Lake St. Clair were eliminated by late 1970. Mercury levels, which had been at 1.24 parts per million in rock bass, 1.62 in channel catfish, and 1.22 in yellow perch, fell to less than the 0.5 parts per million guideline by 1972. Concentrations in a fourth species, walleye, declined by more than 50 percent to an average slightly above 1 part per million. Levels have continued to drop through 1974. There are also indications of a decline in average residues of the walleyes in Lake Erie. Michigan authorities expect that mercury levels in general will continue to decline there, although mercury in larger fish may remain above 0.5 parts per million indefinitely because of the high natural background levels.[108]

Indirect contamination from industrial sources complicates the picture of mercury residues. At a number of plants where court-ordered abatement measures have been monitored, direct discharges to water or air have been successfully curtailed, but indirect leakage continues at significant levels. In one plant, for example, plant waste water discharges contain less than the stipulated limit, but "substantial" extra amounts of mercury are released in seepage from the waste



30-day growth of Jordanella as affected by methylmercury

In this 30-day study, an equal number of newly hatched minnows was placed in each test tank under identical conditions except for the level of methylmercury in the water. As the photograph shows, the growth of these fish was drastically affected by the levels of exposure to methylmercury.

water treatment system and by leaching of sludges buried in a landfill.[109]

Marine Systems

Mercury contamination and cleanup measures are both quickly reflected in marine invertebrates. Since 1970, significant declines in the total mercury burden of coastal organisms have been observed in at least two sites. According to surveys by the Louisiana State Department of Health, the mercury burden in crabs in 1970 was excessively high, with concentrations ranging from 0.42 to 3.96 parts per million and averaging 1.81 parts per million. By 1973, concentrations had decreased significantly, averaging 0.4 parts per million within a range of 0.18–1.01 parts per million.[110]

Similarly, in 1970, oysters from Lavaca Bay, Texas, showed concentrations of mercury averaging 0.8 parts per million—a level just below the contamination level of Minimata's fish and shellfish. The source, mercury discharges of the ALCOA company in Point Comfort, has since been reduced from the 1970 reported rate of 1.45–1.96 pounds per day. Mercury in oysters from the bay had dropped by 1973 to an average level of 0.13 parts per million. The rapid decline may reflect the relatively short lifetime of oysters as well as rapid flushing of mercury-free sedimentation into the estuaries.[111]

The FDA has extensively monitored mercury in marine fish since mercury poisoning from seafood in Japan was reported. An average mercury content of about 0.25 parts per million has been found in tuna, with less than 4 percent over the 0.5 guideline. Halibut show similar levels. The highest levels have occurred in swordfish, with levels exceeding 1 part per million in more than one-half the samples. Smaller species (mackerel, cod) contained some elevated levels but averaged well below the FDA guideline.[112]

Mercury levels in fish caught recently appear to be in the same range as museum specimens of tuna and swordfish caught up to 93 years ago.[113]

Mercury in Humans

Various forms of mercury from treated seeds, soil deposits, or aerial deposits on leaves may be transported to the stems, leaves, seeds, or fruits of plants and thus enter the human diet near the beginning of the food chain.

In 1967, the FDA analyzed several total diet composites for mercury. Levels in dairy products averaged about 0.01 parts per million; they were 0.04 in meat, fish, and poultry; 0.034 in grain cereal; 0.01 in potatoes; and lower in other food groups. In 1970–72 surveys, only the meat, fish, and poultry group contained mercury residues as high as 0.04 parts per million. All others contained levels too low to be detected reliably. By 1973–74, average levels in the meat, fish, and poultry group had declined to about 0.01 parts per million. Average daily intake of mercury in food was calculated at approximately 2.8 micrograms per day (0.04 micrograms per kilogram of body weight), down about one-third from the estimated 3.85 micrograms per day of the fiscal year 1972 period.[114]

Curtailment of agricultural uses of mercurial biocides appears to have limited the sources of mercury pollution in meat and poultry. Most of the mercury pollution in food occurs in fish and shellfish, presumably in the form of methyl mercury.

It must be remembered that other sources of mercury—air, water, consumer products, medicinals—also have a bearing on total human exposure. According to one estimate, the average person in the United States is exposed to at least 23 micrograms per day through these various routes.[115] Extensive monitoring of the mercury body burden of human beings has not been done.

Conclusions

Man's use of mercury has a long history of impacts on the distribution of mercury to the environment, even to the Arctic. Our understanding and control of the complex cycling of mercury in the environment are largely incomplete. Where comparable year-to-year data are available, strikingly divergent measurements have followed curtailment of direct discharges. These differences underscore the need for careful monitoring of all mercury sources and routes of transport.

Mercury-based biocides, until recently used widely to protect seed grain from spoilage, have been linked to declines in bird populations.

LIVING RESOURCES

All living things are vulnerable to human activities. This section focuses on the nation's long lists of endangered plant and animal species and the heavily exploited marine fisheries off our coasts. We also discuss the needs to revise traditional principles of living resource management, to improve our ability to define ecological trends, and to use biological information more effectively as indicators of environmental conditions.

MARINE FISHERIES

Human activity that severely depletes a species or disturbs an ecosystem can threaten the most abundant animal populations and resilient ecosystems on earth. By intense commercial fishing, for example, man has seriously reduced populations of some of the most plentiful fishes off U.S. coasts.

Along more than 88,000 miles of tidal shoreline and out to the edges of the continental shelf, the United States has always been rich in marine fishery resources. For over 300 years, the coastal marine fisheries have provided food, recreation, and commercial industry. The cod and mackerel fisheries of New England and the Middle Atlantic, for example, were a mainstay in the early development of the nation.

Commercial fishing in the United States today employs more than 130,000 fishermen, processors, wholesalers, and distributors.[116] The 1973 harvest was 1.17 million tons of food fish plus 1.20 million tons of fish for pet food, fishmeal, and other uses—worth about $2.8 billion on the retail market.[117]

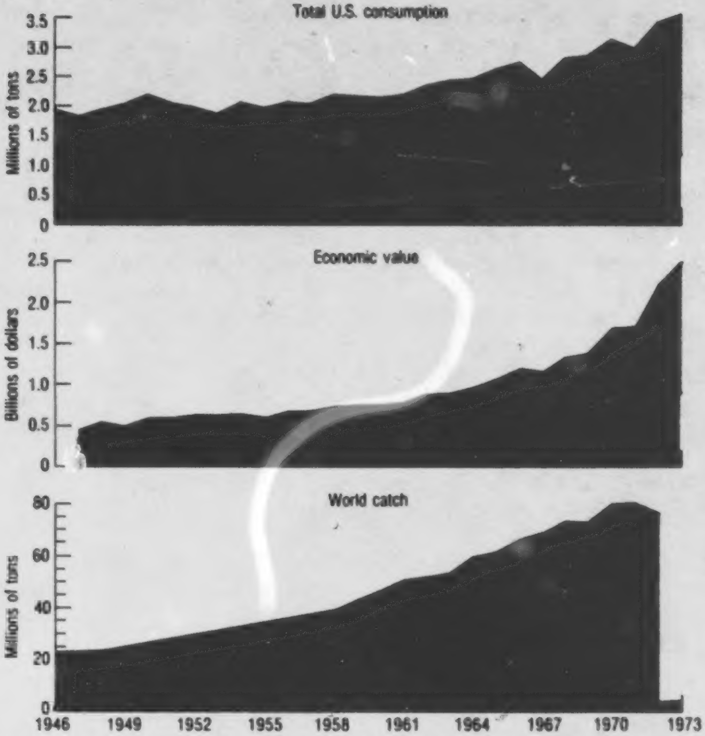
Recreational fishing is also of substantial value to the nation. The estimated number of marine anglers in the United States more than doubled between 1955 and 1970, from 4.6 to 9.5 million. The recreational marine catch in 1970 was estimated at about 800,000 tons, almost one-third the commercial catch, and expenditures involved are estimated at $1.2 billion.[118]

Between 1950 and 1970, the annual commercial harvest by U.S. fishermen remained at about 2.0 to 2.5 million tons annually. Between 1960 and 1970, however, the total fishery harvest taken from waters within 200 miles of U.S. coasts nearly tripled, a sharp increase that was due almost entirely to foreign fishing vessels, which take 4 to 5 million tons each year from waters off our coasts.[119]

The total economic value of the U.S. commercial harvest has more than doubled since 1950, due not to a growing harvest but rather to rising prices. However, during this same time, U.S. consumption of food fish products nearly doubled, raising the economic cost fourfold. Imports account for the differences—the United States now imports over one-half the fish products consumed here, as shown in Figure 41.

Figure 41

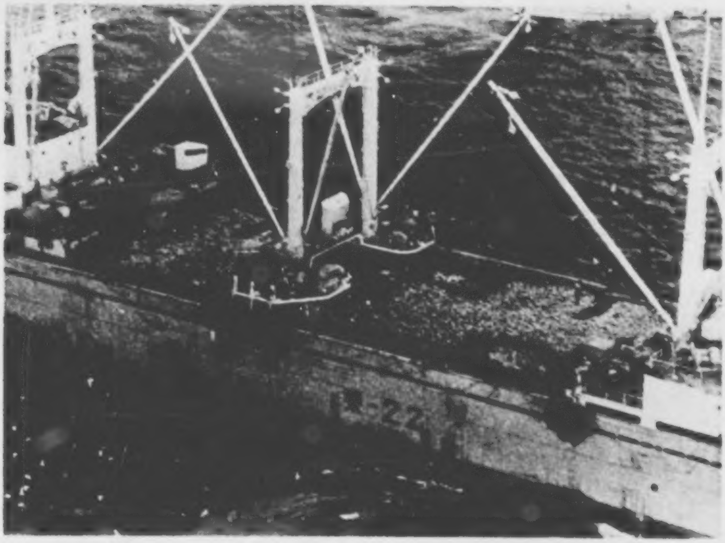
U.S. and World Fisheries Summary, 1946-73



Source: U.S. Department of Commerce, National Marine Fisheries Service, "National Plan for Marine Fisheries" (draft, June 1975), Figures 3 and 4; "A Draft Outline for the National Fisheries Plan" (1974), Figure 3.8.

Increased commercial harvesting of U.S. coastal stocks has severely depleted many species. Fish populations can renew themselves continuously and compensate for harvested losses only if catches are properly managed and if serious disruption of the ecosystem does not occur.

As the world's population and need for food have grown, demands on ocean fisheries have also grown. The worldwide fishery harvest has more than tripled in the past 3 decades. The USSR, Japan, Spain, West Germany, East Germany, Poland, Bulgaria, and Rumania have built large fishing fleets. Many of the vessels are large and are capable of operating for 6 months or more in distant waters. They are equipped with efficient, modern fishing gear. Factory ships accompany the fleets to process the fish wherever they are harvested.



The Soyo Maru, a Japanese fishing vessel, with its bins full of halibut and a deck-load of sole, near the west coast of Alaska.

In recent years these nations have used a technique known as pulse fishing, by which they seek and intensively harvest a particular fish population. When that population becomes depleted from over-fishing, the fleet concentrates on another species.

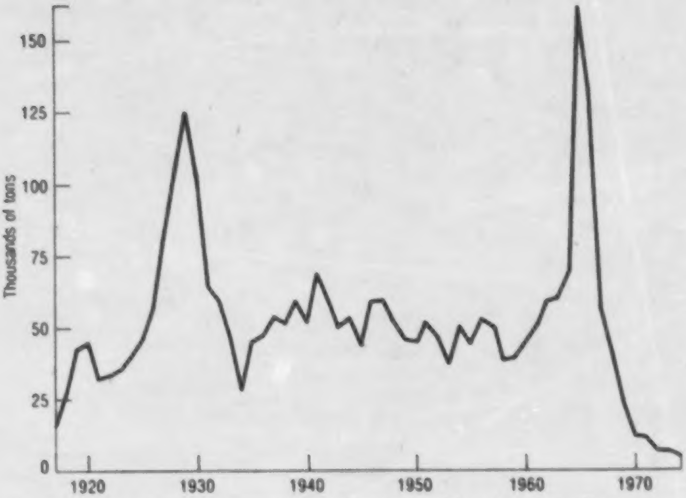
The Northwest Atlantic haddock fishery clearly illustrates the devastation that pulse fishing can produce.[120] Haddock occur along the east coast of North America from the Grand Bank of Newfoundland to southern New England, with the largest numbers on Georges Bank. The haddock have provided a significant harvest for American fishermen since the late 19th century.

Before World War I, the annual U.S. and Canadian harvest was modest, about 25,000 tons. With increased demand and introduction of the otter trawl, a new type of harvesting gear, the haddock harvest spurted to 130,000 tons in 1929. This excessive harvest caused the fishery to decline sharply, but with a reduced fishing effort it recovered over the next decade, and the annual harvest stabilized at about 50,000 tons between the late 1930's and the mid-1960's.

Foreign fishermen then happened upon the haddock. Since the early 1960's, they had been fishing heavily for herring and silver hake on Georges Bank, causing a decline in those two species. Then in 1965, Soviet trawls off New England began picking up an unusually large crop of 2-year-old haddock, and foreign fleets turned to the haddock. The 1965 harvest peaked at 165,000 tons, and within 2 years the population declined sharply, as indicated in Figure 42.

Figure 42

Georges Bank Haddock Landings, 1917-74



Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, *Report to the Congress on Ocean Pollution, Overfishing, and Offshore Development* (Washington, D.C.: Government Printing Office, 1975), Figure 3.

When the International Commission for the Northwest Atlantic Fisheries established catch limits for haddock in 1970 so that stocks could recover, the haddock was too severely depleted. The commission then established a zero quota for 1974, but it is too early to determine whether or how long a recovery may take.

Regulatory efforts are complicated by incidental catches—fish that are accidentally caught along with other species being fished. The incidental catch of haddock is quite substantial; by 1971 it had reached slightly more than 8,000 tons—61 percent of all the haddock taken.[121] Other species are also taken incidentally, sometimes in large quantities. As shown in Table 25, far more of some are taken incidentally than purposely. In addition, other marine animals are also taken incidentally in commercial fishing operations. Porpoises and sea turtles are two that pose a considerable challenge to fishery management. More than 200,000 porpoises are killed annually in Pacific tuna seining operations. Sea turtles, particularly the Atlantic Ridley turtle, are rapidly disappearing because of losses incidental to Caribbean shrimping operations.

Yellowtail flounder, halibut, and bluefin tuna are also depleted stocks. Levels of several other populations are at about one-half those of the early 1960's. Foreign fleets are focusing mostly on mackerel and squid, but the incidental catches of overfished species continue to impede their recovery.

Table 25

Percentage of Various Species Taken as Incidental Catch off New England, 1971

Species	Percent	Species	Percent
Cod	64	Flounders	31
Haddock	61	Other groundfish	66
Ocean perch (redfish)	39	Other fish	86
Silver hake (whiting)	31		

Source: *ICNAF Redbook 1973*, Part 1, Appendix I, Supp. Table 1, cited in U.S. Department of Commerce, National Oceanic and Atmospheric Administration, *Report to the Congress on Ocean Pollution, Overfishing, and Offshore Development* (Washington, D.C.: Government Printing Office, 1975), Table 2.

To reduce the harvests of all species off the U.S. Atlantic coast for a few years, ICNAF designed a total catch quota system. The 1974 quota was set at slightly over 1 million tons, and for 1975 it was 935,000. As yet no quota has been determined for 1976.

Quotas for individual species are also set by international agreement. If all nations were to honor their agreements, it is conceivable that the Northwest Atlantic stocks could recover from overfishing by the early 1980's.[122]

But overfishing in U.S. coastal waters is not attributable entirely to foreign fleets. Depletion of the California sardine fishery, for example, resulted from excessive U.S. harvests.[123] However, the overall situation today off the U.S. Pacific and Alaska coasts is similar to that in the Atlantic. Foreign fishing fleets—primarily Japan's—are so active off our west coast (Figure 43) that scientific assessment can hardly keep pace with the effects of their harvests on remaining stocks.

Pacific mackerel and perch are overfished off California, Oregon, and Washington. In Alaska waters, the halibut, perch, and herring appear depleted, as do a number of species of groundfish (pollock, cod, some flounders, and others).[124] The yellowfin sole catch illustrates overfishing in the Pacific, as shown in Figure 44.

MANAGEMENT OF LIVING RESOURCES

It is common practice in international fisheries arrangements to attempt to regulate the catch by establishing national quotas for certain species. But there are two serious problems, one scientific and the other political.

Quotas have generally been founded on the concept of maximum sustainable yield (MSY), which is defined as the largest catch that may be taken year after year without reducing a population. As it is usually applied, this concept is too simplistic to serve as a scientific basis for stock management.

Figure 43

Japanese Fishing Vessels off Alaska, 1952-72

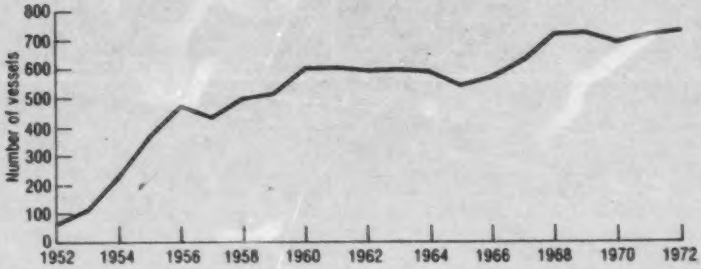
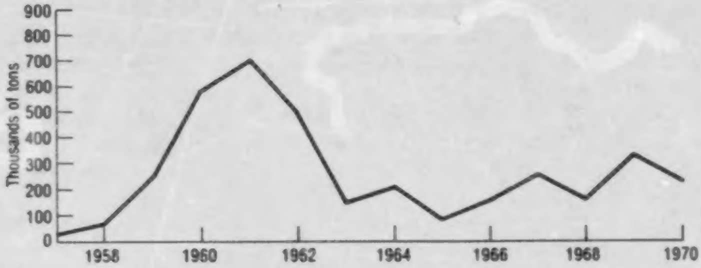


Figure 44

Estimated Bering Sea Flatfish Landings, 1957-70



Source: U.S. Department of Commerce, National Marine Fisheries Service, *"A Draft Outline for the National Fisheries Plan"* (1974), Figure 3.5 and Figure 3.6.

The MSY concept generally involves an assumption that the unexploited population level is stable or at least predictable. In fact natural cycles may alter populations considerably from one year to the next. The assumption therefore can lead to overexploitation during natural population downswings. This apparently occurred with the anchovy catch off Peru in 1972.

Simply applied, MSY disregards the changes in age distribution, sex ratio, social behavior, and reproduction that may occur when a fish population is exploited. Further, MSY is usually concerned with a single harvested species and not with its competitors, predators, or prey. A competitive species, for example, may move in and replace one that is overharvested, thus blocking recovery of the original species.

Basic to MSY and other theories that consider one species alone is the notion that a population recovers when exploitation stops or diminishes. The evidence indicates that some will not. When the California sardine was overharvested into commercial extinction by the 1950's, the anchovy replaced it, and the sardine population did not recover.[125] Only the gray whale, of all the great whales grossly reduced by overharvest, has recovered significantly.[126]

In February and April 1975, the U.S. Appeal of the World Wildlife Fund, the Ecological Society of America, the International Union for Conservation of Nature and Natural Resources, and the Smithsonian Institution and the Council on Environmental Quality sponsored workshops on developing a better scientific basis for management of fisheries and other critical living resources. The major conclusion was that no simple formula, such as MSY, is suitable. Rather, scientific management must consider a species in relation to its ecosystem, and any system must conform to four principles:

- Resources should be managed to prevent irreversible or long-term adverse changes
- Because of inadequacies in knowledge and in management institutions, management decisions should include a safety factor
- Conservation of one resource should not cause waste of another
- Use of a wild living resource should be preceded by survey and analysis of the species and ecosystem involved and should be accompanied by continuous monitoring and assessment, the results to be made available to the public.[127]

Added to the technical problems of scientific management are several practical problems. For example, nations which have not joined the various fishery commissions are not bound by commission recommendations so long as they fish in their own territorial waters or fishery zones or on the high seas. But enforcement even among member nations is not uniform. Most of the commissions lack the means to verify catches and must accept the figures that member nations report. And further, commissions are concerned only with limited areas, not with all of the oceans.

The definition of where nations may claim fishing rights is undergoing change. There appeared to be an emerging consensus at the Law of the Sea Conference for a 12-mile territorial sea and a 200-mile economic zone within which a coastal nation will have jurisdiction over fishing for coastal species and over other resource exploitation. According to the negotiating text prepared by the Chairman of the conference Second Committee, coastal nations would have certain responsibilities as well as rights in their economic zones.[128] Coastal nations would have to take measures to prevent overfishing. Although they would be expected to maintain or restore harvested stocks at levels that can produce "maximum sustainable yields," they would also be obliged to consider effects of a catch on other dependent or associated species with a view to maintaining them above levels that might threaten their reproduction. At least in a preliminary way, then, the international community is considering modification of the traditional MSY concept in recognition of broader ecological principles.

ENDANGERED SPECIES

For every class of animals surveyed by the Department of the Interior's Office of Endangered Species, approximately 1 out of every 10 species native to the United States may be endangered or threatened.[129] This statement appears true for major animal groups of both higher and lower classes—mammals, birds, reptiles, amphibians, and fishes as well as crustaceans, clams, and snails.

With disturbing similarity, recent findings indicate that of all higher plants native to the continental United States, including Alaska, more than 1 out of 10 may be endangered, threatened with becoming endangered, or recently extinct.[130]

Endangered Plants

There are approximately 20,000 species, subspecies, and varieties of higher plants native to the continental United States. Of these trees, shrubs, flowers, ferns, and their relatives, over 2,000 may be in trouble. Their status is shown in Table 26. The situaton in Hawaii is even more disturbing. There, nearly one-half the total diversity in native vegetation has been described as endangered or threatened. These recent findings of the nation's first endangered plant survey

Table 26

Endangered, Threatened, and Extinct Species of Native Higher Plants of the United States [1]

Status	Continental United States (including Alaska)		Hawaii	
	Species, subspecies, and varieties	Percent	Species, subspecies, and varieties	Percent
Total native higher plants	20,000	100.0	2,200	100.0
Endangered	761	3.8	639	29.0
Threatened	1,238	6.1	194	8.8
Extinct	100	0.5	255	11.6
Total	2,099	10.4	1,088	48.9

[1] "Endangered" —in danger of becoming extinct throughout all or a significant portion of their natural range; "threatened"—likely to become endangered in the foreseeable future; "extinct"—limited to recently (or possibly) extinct species only—they cannot be found after repeated searches in the localities where they were formerly observed or in other likely places. Some of the latter appear to be extinct in the wild but are still preserved in cultivation.

Source: Smithsonian Institution, *Report on Endangered and Threatened Plant Species of the United States* (Washington, D.C.: Government Printing Office, 1975), p. 11.

parallel a previous worldwide estimate by the International Union for Conservation of Nature and Natural Resources—that over 20,000 of the world's 300,000 plant species are endangered or are vulnerable and threatened with extinction by the year 2000.[131]

The first national survey was conducted in response to the Endangered Species Act of 1973, which directed the Smithsonian Institution to conduct the study and report to the Congress.[132] Several federal agencies and many botanical experts contributed to the study. The Secretary of the Interior has published a Notice of Review to determine which plants are to be placed on the official U.S. Endangered Species List. Table 27 lists some of the plants considered endangered or threatened.

Forty of the 1,100 native U.S. trees were identified in the national survey, including several oaks, 5 cypress, 3 Arizona ash, four Texas hawthornes, 2 willows, and a Florida magnolia and yew. The first native plant known to become extinct in the wild was Georgia's flowering Lost Franklinia, a tree which, except for a few cultivated specimens, had vanished by 1806.

The endangered and threatened plants described in the national survey were restricted to native higher plants only. Consequently, the survey excluded hybrids, horticultural variations, and all of the lower plants, the mosses, lichens, fungi, and algae.

But even with these exceptions, the number of plants described as endangered or threatened warrants concern. Most of them exist only in localized geographic areas where they have been severely depleted by the alteration of natural habitats or exploitation by private and commercial collectors. The majority are harbored in specialized habitats such as mountain tops, valleys, islands, bogs, and deserts. Many are restricted to small, unique areas. A bank of the Apalachicola River in northwest Florida, for example, has 14 plants found nowhere else. Threatened plants are also relatively concentrated in parts of the southern Appalachian Range and Arizona, California, Florida, Hawaii, Nevada, Oregon, Texas, Utah, and Washington.

Plants and their native habitats are destroyed when we develop cities and roads, farm and irrigate fields, clearcut forest, strip mine hills, spray with herbicides, and otherwise alter the earth's surface. They are also adversely affected by nonnative plants; about 3,800 nonnative species have been transported to the United States, most of them to Hawaii. Once free of the diseases and pests that had kept them in check, they often become aggressive weeds that have a competitive advantage and thus contribute to the rarity of native species.

Some of the rare and depleted plants are highly prized and are exploited by collectors. In fact, their rarity often makes them more desirable to many collectors. Lilies, orchids, primroses, and palms, for example, are sought for their beauty. Nearly one-third of all native cactuses—heavily exploited as potted plants—may be endangered or threatened. The supply of medicinal plants such as ginseng

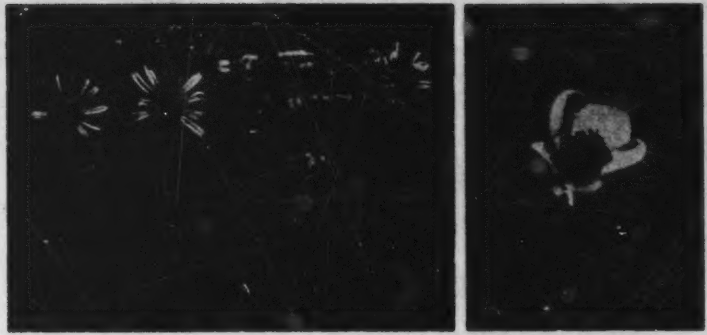
Table 27

Examples of Endangered and Threatened Plant Species

Common name (and family)	Scientific name	Range	Status
Wiliwilinui (bellflower family)	*Rollandia angustifolia var. ochracea*	Forests on upper levels of mountains of Oahu Island	Threatened
Beavertail cactus (cactus family)	*Opuntia basilaris*	Mainly in the Mojave and Colorado Deserts of southern California and western Arizona	Two varieties threatened, one variety endangered
Button cactus (cactus family)	*Epithelantha bokei*	Texas	Threatened by collection and commercial exploitation
Silversword (aster family)	*Argyroxiphium kauense*	On lava of Mauna Loa, Hawaii	Endangered by collection and grazing
Tennessee coneflower (aster family)	*Echinacea tennesseensis*	Cedar glades on limestone near Nashville, Tennessee	Endangered—only a few populations are known, in an area subject to residential development
Orcuttia grass (grass family)	*Orcuttia californica*	California—overgrazed grassland in Sacramento and San Joaquin Valleys and mudflats in Riverside County	All three varieties have highly restricted populations and are endangered to the point of approaching extinction
Century plant (lily family)	*Agave utahensis* var. *nevadensis*	Dry, stony limestone slopes in eastern Mojave Desert, California	Threatened
Mariposa lily (lily family)	*Calchortus obispoensis*	San Luis Obispo County, California	Threatened
Point Reyes meadowfoam (meadowfoam family)	*Limnanthes douglasii var. sulphurea*	Marshy pastures on Point Reyes Peninsula, California	Threatened

Ramshead (orchid family)	*Cypripedium arietinum*	Woods, swamps, and bogs in New England and upper Great Lakes states	Threatened by habitat destruction and overzealous collection
Golden frog-arrow (orchid family)	*Platanthera integra*	Savannahs, open acid bogs, pine barrens, and wet meadows in the southeastern states	Threatened by habitat destruction and overzealous collection
Indigo bush (pea family)	*Dalea arborescens*	Mojave Desert, California	Threatened
Shiny locoweed (pea family)	*Astragalus lentiginosus* var. *micans*	Sand dunes in Eureka Valley, California	Threatened
Desert poppy (poppy family)	*Arctomecon merriamii*	Death Valley region of California and Nevada	Threatened by indiscriminate collection
Howell's evening primrose (primrose family)	*Oenothera deltoides* var. *howellii*	Sand dunes in Contra Costa County, California	Endangered to the point of approaching extinction
Harvard plum (rose family)	*Prunus harvardii*	Rocky slopes and canyons in Trans-Pecos region of western Texas	Threatened
Lemhi beardtongue (snapdragon family)	*Penstemon lemhiensis*	Lemhi Valley region of Montana and Idaho	Threatened by overgrazing
Live-forever (stonecrop family)	*Dudleya* spp.	Coastal scrub in California	Some species endangered, others threatened. These attractive succulents are exploited by collectors
Lost Franklinia (tea family)	*Franklinia alatamaha*	Formerly along the Altama River, Georgia; last collected in the wild in 1803	Extinct in the wild, but grown in cultivation. The genus name commemorates Benjamin Franklin

Source: Smithsonian Institution, *Report on Endangered and Threatened Plant Species of the United States* (Washington, D.C.: Government Printing Office, 1975); U.S. Fish and Wildlife Service.



The Tennessee coneflower (left) and the Lost Franklinia (right) are two of the native plants that were listed in the first nationwide endangered plant survey.

and goldenseal has been depleted because of heavy collecting. Unusual plants like the Venus flytrap and pitcher plant are also commercially exploited.

Habitat preservation is the major key to protecting our endangered plants. The Smithsonian Institution has stressed the point that transplanting and artificial cultivation are unsatisfactory, except as a last resort. Most such attempts to preserve individual species are not practical.

Endangered Animals

The success of some state and federal efforts to protect and restore endangered animal populations was encouraging in some cases even before enactment of the Endangered Species Act, and the number of accomplishments continues to grow. Measures responsible for the successes include regulation or suspension of commercial use of a depleted species, control of pesticides and other toxic pollutants, preservation and management of natural habitat, and suppression of pest organisms or other nonnative, introduced species. In some special cases, the recovery of seriously depleted, endangered populations has also been aided through a program of captive breeding and reintroduction to the wild.[132]

The reduction of commercial harvesting pressure has allowed recovery of some endangered animals. For example, the American alligator, once occurring in vast numbers throughout the Southeastern states, had been severely reduced by the 1950's, mostly by excessive hide hunting. State governments then began to protect the species and attempted to prevent poaching and commercial utilization. In 1967, the alligator was placed on the U.S. Endangered Species List, a measure which supported the states' efforts to stop illegal hide traffic. Combined state and federal management and enforcement programs subsequently were successful enough to allow the remaining populations to increase.

The Key deer and the American alligator exemplify endangered U.S. animals that have benefited from state and federal protection.

Because of these measures, the alligator is no longer believed to be endangered in some areas. A recent population survey estimates that more than 730,000 now exist in over 45,000 square miles of suitable habitat in the southeastern United States.[134]

Also benefiting from reduction in harvesting is the gray whale. At one time populations were found in the Eastern and Western North Pacific as well as in the North Atlantic. The Atlantic population was exterminated by commercial harvesting in the 18th century. The Northwestern Pacfiic population had also been thought extinct, but a few may still survive there.

The Eastern Pacific population, which migrates along the California coast, was also heavily exploited by commercial whalers, and by the early 20th century it was dangerously small—probably only a few hundred. However, as a result of the 1946 international agreement that bans hunting the species, the Eastern Pacific population of gray whales today numbers about 11,000.[135] Unfortunately, such recovery has not occurred in other species of whales.

Habitat management and the establishment of wildlife sanctuaries are additional tools that foster the recovery of endangered animal populations. The total population of Key deer, a subspecies of white-tailed deer that inhabits the Florida Keys, had been reduced to only 30 individuals by 1949. Since the National Key Deer Refuge was established in 1963, the population has increased to about 600.[136]

The control of pest organisms and other nonnative, introduced species has also been helping other native endangered species toward recovery. The Aleutian Canada goose, which once bred on many of the Aleutian Islands, was nearly exterminated by foxes that had been brought there. Fewer than 300 geese survived on Buldir Island, where no foxes had been introduced. Although a number of the geese were captured and taken to the Fish and Wildlife Service Patuxent Wildlife Research Center in Maryland, some of the foxes were removed from Amchitka and Agattus. Captive-raised geese were recently released on the two islands, and the group from Agattus appears to be producing young and migrating normally.[137]

There have been other attempts to aid a severely depleted species by captive breeding in conjunction with management in the wild. One that is just beginning to look hopeful is the whooping crane program. In 1941, only 15 whooping cranes wintered at the Arkansas Migratory Bird Refuge. Through enforcement of protective laws, publicity, and careful maintenance of breeding and wintering areas by the United States and Canada, there were 57 by 1970. Today, the wild flock numbers 49, and there are 25 whooping cranes in captivity. Most are at Patuxent. In May 1975, the first chick bred in captivity hatched, and although it died within a few days, other attempts will be made. In an effort to establish a second wild flock of whooping cranes, 14 eggs were placed in the nests of wild sandhill cranes.[138]

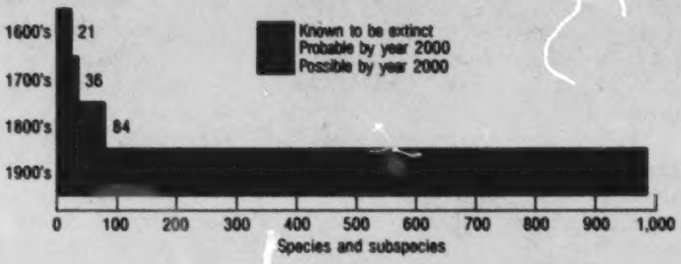
Most of the recoveries described above are the result of integrating several types of management action. For many species it may be necessary, for example, to improve habitat, propagate artificially, and eliminate pests at one time. Typical are three species of western trout that were originally listed under the Endangered Species Conservation Act of 1969—the Lahonton cutthroat trout, which occurs in California and Nevada; the Paiute cutthroat trout, which is restricted to mountain streams in east central California; and the Arizona trout, which occurs in the headwater tributaries of the Salt River in Arizona.[139] They became endangered because of the destruction or modification of their stream habitats and the introduction of exotic, nonnative trout species.

Since 1969, the U.S. Fish and Wildlife Service, in cooperation with state fish and game departments, has conducted programs to propagate and reintroduce the three species, improve stream habitat, and remove the nonnative trout and hybrids. None is now considered endangered and all three have been reclassified as threatened.[140]

Some species have been helped but many are still very much endangered. The grizzly bear was recommended for inclusion on the U.S. List of Threatened Species in 1975. The red wolf, which once roamed the entire Southeastern and South Central United States, is now gone, except for a small area in Texas and possibly Louisiana, where the few remaining have been mating with coyotes.[141] Birds of prey like the bald eagle, peregrine falcon, and osprey seem to be undergoing modest and precarious recoveries because of pesticide controls and conservation efforts, but they are not out of danger. There are 405 animals on the U.S. Endangered Species List today, 109 of which are indigenous to the United States. More will undoubtedly be added. Figure 45 shows the estimated number of vertebrate species that have become extinct since 1600 and projects estimates to the year 2000.

Figure 45

Extinct Species and Subspecies of Vertebrate Animals, Worldwide, 1600's-1900's



Source: Data on extinct animals are from Davis, J.A., New York Zoological Society, the Zoological Park, Bronx Park, New York, January 1972. Projections are from International Union for Conservation of Nature and Natural Resources, *Red Data Books*, Lausanne, Switzerland, in George Uetz and Donald L. Johnson, "Breaking the Web," *Environment*, XVI (December 1974), p. 33, © Scientists' Institute for Public Information.

This "graveyard" at the Bronx Zoo dramatizes the fact that many animal species are known to have become extinct during recent history.

Within the United States we possess a formidable amount of information pertaining to biological conditions and trends. However, many of the data result from studies and monitoring programs with limited scope and application. Their design and use are often parochial. Although a particular data collection activity may be very useful for specific purposes, its benefits may not be fully realized because it is not always widely disseminated and coordinated with other programs.

The federal government has been expanding efforts to compile and analyze nationwide air and water quality data for several years. We are just now focusing on the coordination of diverse *biological* data bases and programs that are valuable to assessing biotic conditions and trends. The task is formidable, partly because of the considerable difficulty and cost of most types of biological monitoring and also because of the great diversity in objectives, types, sources, quality, and availability of data.

Access to rapidly identifiable and available biological monitoring data is growing more important to environmental analysts and evaluators, to decisionmakers at all levels of government, to planners, and to regulators. Some of these data describe trends of direct social and economic importance, the decline of a fishery or the outbreak of a pest species, for example. Other data describe changes in living populations or ecosystems—the "early warning" indicators of environmental disturbances.

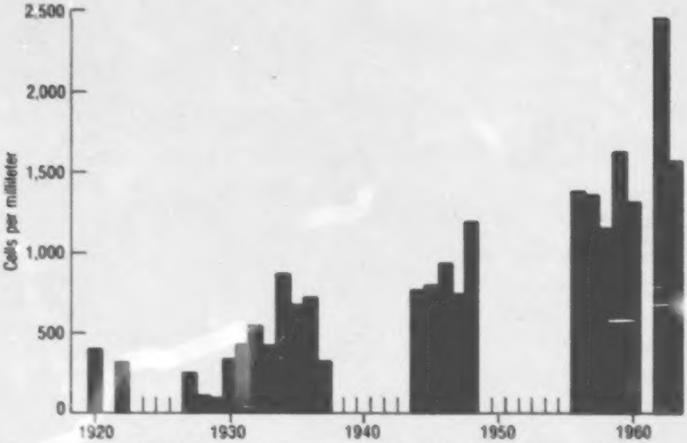
A classic example is the pollution and accelerated eutrophication of Lake Erie, which was caused by man and became evident by the middle of the 20th century. Long before the decline of Lake Erie's fishery harvests and long before some of its beaches were closed or widespread mats of algae and scum were seen, several more subtle biological indicators of its condition could be observed.

During 25 of the 43 years between 1920 and 1963, the Division Avenue Filtration Plant in Cleveland had collected daily samples of algae in the Lake Erie water that it processed. Figure 46 shows that the average abundance of algal cells per water sample progressively increased. In addition, the intensity and duration of the spring and autumn algae blooms grew through the years, and the summer and winter periods of normally slow algal growth became shorter and less defined as the years progressed. Further, the most abundant species of algae observed in the bloom periods changed over the years to more pollution-tolerant and nuisance types.[142]

Another group of biological indicators which signaled Lake Erie's pollution problems was the bottom-dwelling organisms. From a comparison of collections taken at 40 benthic sites in western Lake Erie in 1961 and in 1930 dramatic changes are obvious—a ninefold increase in the average abundance of pollution-tolerant segmented worms (Oligochaeta), many of which were of the sludgeworm

Figure 46

Algae Levels in Lake Erie, 1920-63



Source: C.C. Davis, "Evidence for the Eutrophication of Lake Erie from Phytoplankton Records," *Limnology and Oceanography*, IX (1964), p. 277.

family, a fourfold increase in the number of bloodworms (Chironomidae), but a reduction of less than 1 percent of the pollution-intolerant burrowing mayfly (*Hexagenia*).[143]

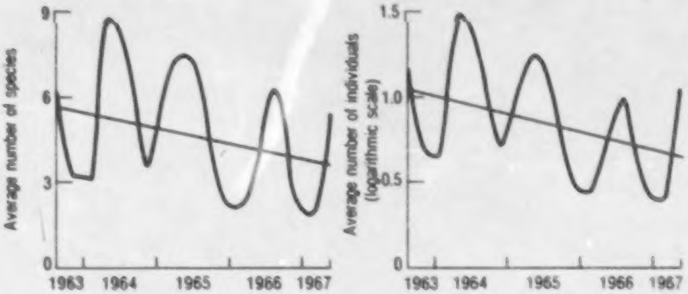
The value of biological indicators is by no means restricted to long-term trends. In fact, populations and communities of living organisms are frequently our best early warning indicators of environmental change. On the other hand, most populations naturally exhibit daily, seasonal, or other periodic cycles that must be taken into account when assessing overall trends. As seen in Figure 47, for example, the abundance and diversity of fishes in Maryland's Patuxent estuary declined through the mid-1960's, but these patterns must be examined against a background of strong seasonal cycles.[144]

In order to help scientists and policymakers better utilize and evaluate results of the myriad individual biological monitoring programs conducted by federal, state, and private organizations over the country, the Council has initiated a National Inventory of Biological Monitoring Programs in collaboration with the Energy Research and Development Administration, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service. The work is being conducted by Oak Ridge National Laboratory with the assistance of The Institute of Ecology.

The inventory will identify and describe programs, organizations, and data repositories pertaining to trends in the dynamics, status, behavior, productivity, management, and uses of populations of living natural resources and in the condition, structure, diversity, and perturbations of biological communities and ecosystems. The geo-

Figure 47

Fishes in Maryland's Patuxent Estuary, 1963-67



Source: A.J. McErlean, et. al., "Abundance, Diversity and Seasonal Patterns of Estuarine Fish Populations," *Estuarine and Coastal Marine Science*, 1(1) (1973), Figures 4 and 6.

graphic area covered will be the United States, U.S. territories, the U.S. continental shelf waters, and study areas for the marine fisheries, the migratory populations, and worldwide living resources important to the United States. Data pertaining to the status of endangered and threatened species, marine mammals, and important natural areas, including wetlands, will be emphasized. Chapter 7 describes the inventory in more detail.

POPULATION

Rapidly expanding population is the most pressing long-range problem in the world today. Growing populations require more food, energy, and other scarce resources and thus increase the stresses that we place on the environment.

The fundamental importance of population growth in determining quality of life dictates that any environmental discussion include an assessment of population trends. U.S. population trends are reviewed here, and world population developments are treated in Chapter 5.

During the past year the U.S. population increased by about 1.6 million, passing the 213 million mark in February 1975. The population growth rate for 1974 increased to 0.75 percent from 0.71 percent in 1973. Immigration remained about constant, but the natural increase—the excess of births over deaths—for 1974 was slightly higher than in 1973.* In 1975, the natural increase is again expected to rise moderately, and immigration will be more than one-third greater due to the large influx of refugees from Southeast Asia.

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*In 1974 there were 3,166,000 births (29,000 more than in 1973) and 1,933,000 deaths (40,000 fewer than 1973) for a net natural population increase of 1,233,000. Immigration added 360,000. These figures do not reflect the undercount, estimated by the Bureau of the Census at 5.3 million as of July 1, 1974, or illegal immigrants.

The most important indicator of long-term trends in population growth is the total fertility rate, an estimate of the number of children which the average woman will bear throughout her childbearing years; it is based upon actual fertility rates for a given year. If U.S. death rates were to remain constant and there were no net immigration, a total fertility rate of 2.1 would eventually achieve a zero growth rate. In the United States, the total fertility rate rapidly declined from a peak of 3.7 in the late 1950's and is now below the replacement level (see Figure 48). For the last 3 years the rate has continued to drop; it was 2.02 in 1972, 1.90 in 1973 and 1.86 in 1974.[145]

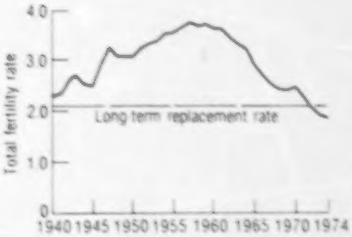
Even with these reduced fertility rates, the number of births increased in 1974 because there were more women in their reproductive years—a result of the post-World War II "baby boom." This population bulge will be an important factor in birth statistics over the next decade. Thereafter, the number of prospective mothers in their prime childbearing years (20–29) will start to decline.

Declining fertility rates in the United States are associated with other striking changes in demographic characteristics. One is an aging of our population. Less than one-quarter of our population is under 14 years, compared with almost 30 percent in 1960, and approximately 10 percent is over 65, compared to 9 percent in 1960.[146]

Another change is reduced family size. Figure 49 shows the change in the average household size between 1940 and 1974. In general, there is a higher proportion of single people and of one- and two-child families. The smaller family size reflects a significant change in preferences. American women of all ages, particularly younger

Figure 48

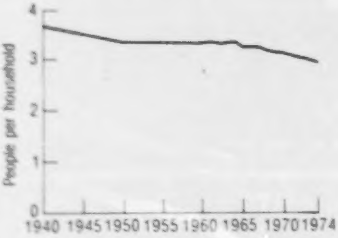
U.S. Total Fertility Rate, 1940-74



Source: U.S. Bureau of the Census, *Current Population Reports*, Series P–25, No. 545, "Estimates of the Population of the United States and Components of Change: 1974 (with Annual Data from 1930)" (Washington, D.C.: Government Printing Office, 1975), p. 5.

Figure 49

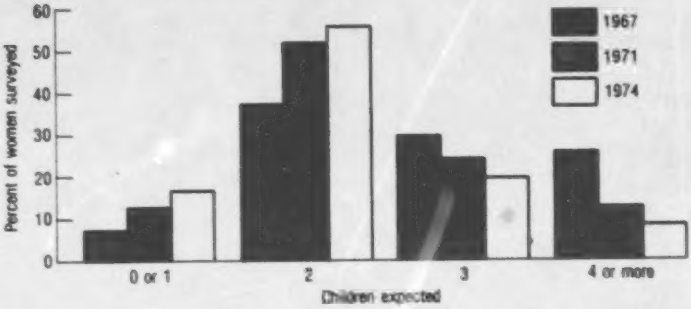
Average Population per Household, 1940-74



Source: U.S. Bureau of the Census, *Current Population Reports*, Series P–20, No. 266, "Households and Families, by Type: March 1974 (advance report)" (Washington, D.C.: Government Printing Office, 1974), p. 3.

Figure 50

Children Expected, All Wives, Ages 18-24, 1967-74



Source: U.S. Bureau of the Census, *Current Population Reports*, Series P–20, No. 277, "Fertility Expectations of American Women: June 1974" (Washington, D.C.: Government Printing Office, 1975), p. 2.

women, expect to have fewer children than they did a few years ago. As indicated in Figure 50, in 1967 more than one-half the wives surveyed said that they wanted more than two children; by 1974 this proportion had dropped to about 30 percent. In 1967, more than one woman in four in the prime childbearing years expected to have four or more children; by 1974 only one young woman in ten expected to have so many. In 1967, married women who had not yet had children expected, on the average, to have 2.1 births during their lifetimes; in 1974, married childless women expected to have only 1.6 births during their lifetimes.[147]

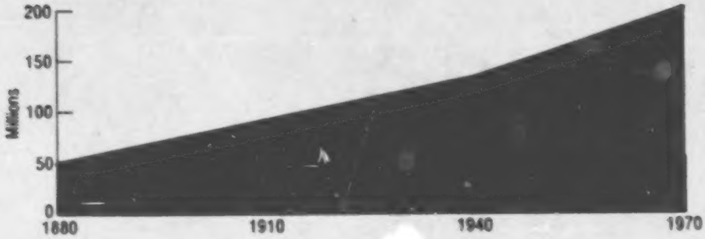
POPULATION DISTRIBUTION

All the demographic factors mentioned so far are related to the reduced rate of population growth. There have also been remarkable changes in relative growth rates among regions and in rural and urban areas. As Figure 51 shows, our rural population has remained about constant since the late 19th century. It was actually declining slowly from 1940 to 1970, but since then there has been an increased tendency for families to settle in nonmetropolitan areas and smaller Standard Metropolitan Statistical Areas. This trend is discussed in Chapter 2.

Figure 52 shows the growth pattern for different size SMSA's from 1960 to 1970 and from 1970 to 1973. The growth rate in larger metropolitan areas has dropped substantially from what it was between 1960 and 1970. In smaller metropolitan areas it increased slightly. But in nonmetropolitan areas the annual growth rate has increased almost a full 1 percent. These areas are now growing at a rate double the total population growth rate.

Figure 51

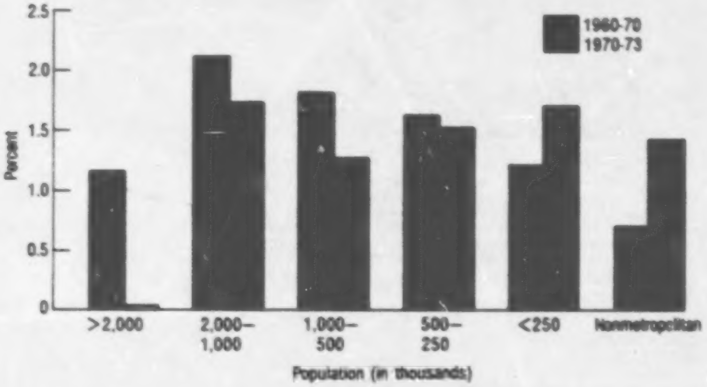
Rural and Urban Population Distribution in the United States, 1880-1970



Source: Based on Regional Plan Association, *Growth and Settlement in the U.S.: Past Trends and Future Issues*, RPA Bull. 124 (New York, 1975), Chart 10, and U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957* (Washington, D.C.: Government Printing Office, 1960).

Figure 52

Average Annual Growth Rates in Metropolitan Areas, 1960-73



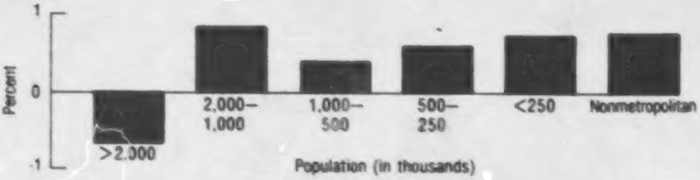
Source: U.S. Bureau of the Census, *Statistical Abstract of the United States: 1974* (Washington, D.C.: Government Printing Office, 1974), Tables 21 and 22; U.S. Bureau of the Census, *Current Population Reports*, Series P–25, No. 537, "Estimates of the Population of Metropolitan Areas, 1972 and 1973, and Components of Change, since 1970" (Washington, D.C.: Government Printing Office, 1974), p. 24.

Even more interesting are the figures on net migration within the United States, as shown in Figure 53. There has been a net migration from the largest to the medium size and small areas and to nonmetropolitan areas.

In addition to the shift away from large cities, there have been some significant shifts in regional growth rates. As indicated in Figures 54 and 55, the Western United States has traditionally grown

Figure 53

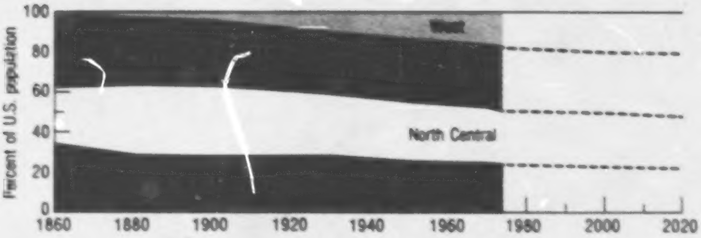
Net Migration to Metropolitan Areas, 1970-73, as a Percentage of the 1970 Population



Source: U.S. Bureau of the Census, *Current Population Reports*, Series P–25, no. 537, "Estimates of the Population of Metropolitan Areas, 1972 and 1973, and Components of Change, Since 1970" (Washington, D.C.: Government Printing Office, 1974), p. 24.

Figure 54

Regional Population Distribution, Actual 1860-1974 and Estimated 1974-2020



Source: • Regional Plan Association, *Growth and Settlement in the U.S.: Past Trends and Future Issues*, RPA Bull. 124 (New York, 1975), Chart 8, based on U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957* (Washington, D.C.: Government Printing Office, 1973), *Statistical Abstract of the United States,* [illegible] Washington, D.C.: Government Printing Office, 1973), *Current Population Reports, Population Estimates and Projections*, Series P–25, No. 530, "Estimates of the Population of States, by Age, July 1973 and 1974" (Washington, D.C.: Government Printing Office, 1973).

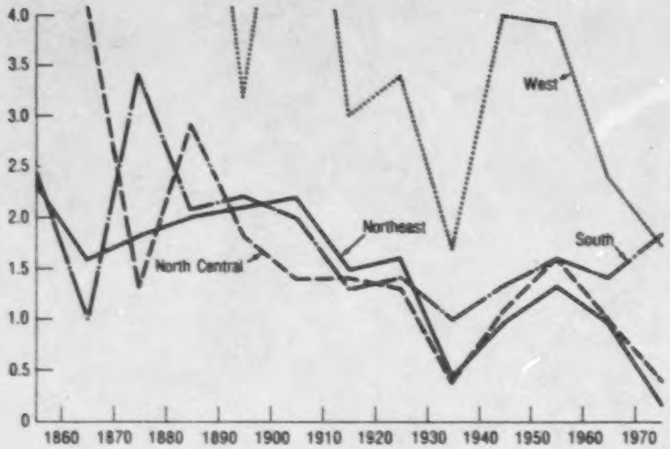
faster than the rest of the country, but over the last 2 or 3 decades its growth rate has dropped rapidly to the level of the other regions. From 1960 to 1970 the Western, coastal, and Great Lakes states were the fastest growing areas. Since 1970 the South is growing as rapidly as the West, and the other states have dropped off.[148] The Great Lakes states have experienced a net out migration.

IMPLICATIONS OF CHANGES

The most important implication of the changing demographic trends reported above is their impact on the total U.S. population. The Bureau of the Census has prepared a new series of population projections based on the July 1974 population, revised mortality rates (decreasing slightly to 2020 but not thereafter), net immigra-

Figure 55

Regional Growth Rates, 1860-1974



Source: a Regional Plan Association, *Growth and Settlement in the U.S.: Past Trends and Future Issues*, RPA Bull. 124 (New York, 1975), Chart 8, based on U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957* (Washington, D.C.: Government Printing Office, 1973), *Statistical Abstract of the United States: 1973* (Washington, D.C.: Government Printing Office, 1973), *Current Population Reports, Population Estimates and Projections*, Series P-25, No. 538, "Estimates of the Population of States, by Age, July 1973 and 1974" (Washington, D.C.: Government Printing Office, 1973).

tion at 400,000 per year, and total fertility rates of 2.7 (Series I), 2.1 (Series II), and 1.7 (Series III). The results of these projections are shown in Figure 56, which indicates the total number of surviving children born each year, and Figure 57, which shows the size of the total population.

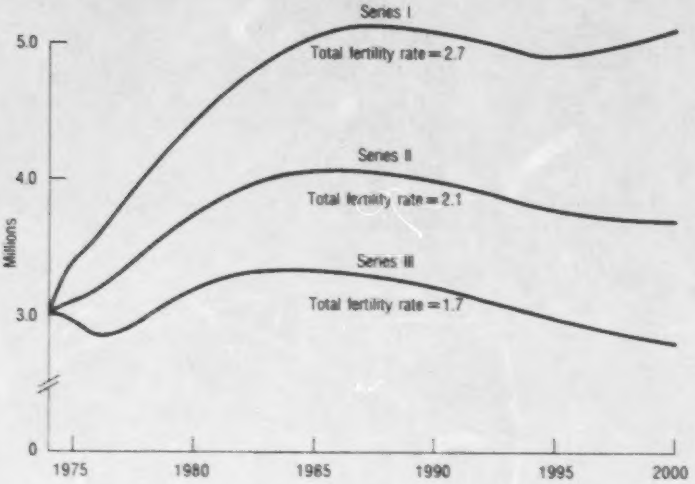
Figure 56 shows that births under the Series I assumptions peak temporarily at 5.2 million in 1988 but soon begin to climb again. Series II peaks at 4.1 million in 1986 and Series III at 3.3 million in 1984. As indicated in Figure 57, total population would continue to increase because of immigration even if total fertility rates remain at 2.1 (Series II). But in Series III, the growth rate would fall to zero by 2020 (as we reach a population of 252 million) and then would begin to decline.

These projections show that if the United States were to maintain a total fertility rate of 2.7 (the level in 1966), the population would be about half again greater 50 years from now than if the total fertility rate were 1.7, as assumed for Series III. The difference of 132 million people has substantial implications in terms of resource consumption, environmental stress, and the general quality of life.

If the present U.S. total fertility rate of 1.86 were to last, the pattern of population growth would fall between the projections for Series II and III.

Figure 56

U.S. Birth Projections, 1975-2000



Source: Derived from U.S. Bureau of the Census, *Current Population Reports*, Series P-25, No. 541, "Projections of the Population of the United States, by Age and Sex, 1975 to 2000, with Extensions of Total Population to 2025 (Advance report)" (Washington, D.C.: Government Printing Office, 1975).

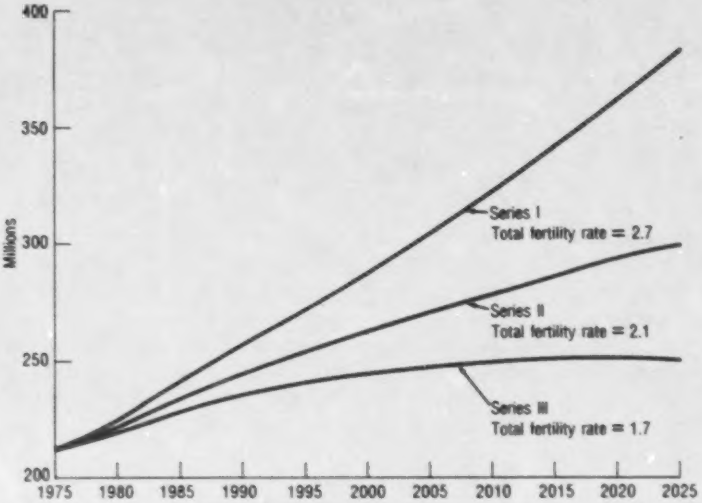
There are other consequences of our changing demographic characteristics. For example, the trend toward an older population has long-term implications for our social security system. Because the system tends to finance benefits out of current income, a higher ratio of retired people to working people (which would follow from a reduced growth rate) will increase the amount that workers have to contribute. However, this effect would not begin to be noticed for another 20 years and will be mitigated by an increase in employment of women.

On the other hand, the total dependency ratio—the ratio of retired elderly plus dependent young to the total labor force—will fall, and this change will occur quickly. Under the Series III assumptions, the percentage of the population under 20 years old will fall from 35 to 26 percent between 1975 and 2000. Among other impacts, this decline will substantially reduce municipal expenditures for elementary schools and teachers.

Other implications of smaller and later families are that a larger percentage of women will be entering the working force, which will give families higher incomes. This change will be all the more noticeable because a smaller share of the family income will be spent on caring for children. How families will spend their higher "discretionary" income can have a significant effect on environmental quality, resource depletion, and economic growth. The changing family size

Figure 57

U.S. Population Projections, 1975-2025



PROJECTIONS *(thousands)*			
YEAR	SERIES I	SERIES II	SERIES III
1975	213,641	213,450	213,323
1980	225,705	222,769	220,356
1985	241,274	234,068	228,365
1990	257,663	245,075	235,581
1995	272,685	254,495	241,198
2000	287,007	262,494	245,098
2005	303,144	270,377	247,[illegible]
2010	322,048	278,754	250,1[illegible]
2015	342,340	286,960	251,883
2020	362,348	294,046	251,884
2025	382,011	299,713	250,421

Source: U.S. Bureau of the Census, *Current Population Reports*, Series P–25, No. 541, "Projections of the Population of the United States, by Age and Sex, 1975 to 2000, with Extensions of Total Population to 2025, advance report, (Washington, D.C.: Government Printing Office, 1975), p. 1.

and income will also have implications in terms of the housing market, as Chapter 2 pointed out.

The 1974 report on *National Growth and Development* discussed in some detail the implications of the apparent change in population distribution.[149] For instance, the shift away from large cities should help in solving some of our worst air quality problems, but the shift to western cities, many of which have unfavorable meteorological conditions, may have the opposite effect. People who move from town to a more rural area may consume more gasoline because there is little public transportation available, and they may also increase the costs of those public services which can be supplied more efficiently to a higher density population.

The shift in population growth rates presumably reflects a shift in people's perceptions about how to improve their quality of life. We have traditionally perceived small towns and rural areas as desirable places to live, and analyses of how the quality of life is affected by community size generally demonstrate that environmental, social, and political problems tend to diminish with the size of communities.[180]

A study recently completed for EPA attempted to develop "quality of life" indices for each of the U.S. SMSA's, but the metropolitan areas were classified according to size so that the study does not permit comparisons among areas with large population differences.[181] Nevertheless, it is interesting to look at some of the quality of life indicators in conjunction with population growth rates for metropolitan areas of similar size. The study developed separate (but somewhat overlapping) indicators for economic, political, environmental, health and education, and social considerations that were perceived as affecting the quality of life. Such an effort, of course, necessarily involves an arbitrary weighting of factors that can be measured only imperfectly.

Statistical analyses of these data show a positive correlation between the indicator for environmental quality and the rate of population growth for large SMSA's, although not for medium size SMSA's. The environmental quality indicator included measures of air, water, and noise pollution, solid wastes, and recreational opportunities. For larger SMSA's, there is also a correlation between population growth and the indicator for social quality, which includes measures of economic well-being, educational attainment and expenditures, recreational opportunities, health, and racial, sexual, and spatial characteristics of the SMSA. Surprisingly, the indicator attempting to measure "economic quality" showed no significant correlation with population growth rates in either large or medium size SMSA's. Even when all five indicators were included in the analyses at one time, they explained no more than half the variation in the growth rates.

Further analysis of growth rates (or migration rates) would be useful. People presumably move to improve the quality [illegible] their lives. A better understanding of the relative importance that people in fact place on the many factors affecting quality of life would help policymakers to assign priorities among programs aimed at improving these factors.

ENERGY TECHNOLOGY

The impact of current energy technologies on the environment is well recognized. Emissions from energy resource extraction, conversion, and end use can and do cause substantial pollution.

Some new and emerging technologies offer the promise of reduced environmental impacts. It is important, therefore, that projections and evaluations of environmental impacts of emerging energy technologies be made while they are in the research and development stages. Impact analysis plus the monitoring and projection of trends in energy supply, conversion and end use will allow research to be focused on those technologies that will indeed reduce pollution and on making environmentally damaging technologies more acceptable.

Section 11 of the Federal Nonnuclear Energy Research and Development Act of 1974 [152] directed the Council on Environmental Quality to report annually on the probable environmental consequences of trends in the development and application of energy technologies. This section is CEQ's first such report. It presents a forecast of U.S. energy supply and demand and discusses some implications of the forecast for emerging energy technologies and their environmental impacts.

ENERGY SUPPLY AND DEMAND FORECASTS

The Council on Environmental Quality, in connection with several activities related to energy and the environment, engaged Stanford Research Institute (SRI) to study the economics of alternative scenarios for the year 2000 for extracting, converting, and distributing energy from the Western United States. An SRI computer model was used to estimate these economic relationships and supply patterns. The study also analyzed the prospective demand for synthetic fuels within the framework of national energy supply-demand scenarios.[153]

The study assumed that end use demand levels for the year 2000 would result in a total gross energy input into the economy of 140* quadrillion Btu's, an energy growth rate of about 3 percent. All other economic and volumetric relationships between energy supply and demand, both national and regional, were calculated by a computer model.

The model (see Figure 58) estimates that synthetic fuels made from coal and oil shale will meet about 16 percent of the nation's total energy demand by the year 2000. If prices of imported oil are lower or if domestic oil and gas resources are more plentiful at lower prices, these emerging technologies will meet a smaller share of demand.

Further, oil from shale increases significantly after the year 1995, providing nearly 5 percent of the nation's energy demand by 2000. Coal-based synthetic fuels become sizable before 1990 and supply 11 percent of the nation's energy requirements by 2000. Coal production from all regions doubles between now and 1985 and increases fivefold by 2000. In 2000, low sulfur western coal will provide for 20 percent of all our energy needs; another 15 percent will come from eastern coal of higher sulfur content. About half the coal will be burned directly and the rest used to make synthetic fuels.

The study indicates that about one-half the synthetic fuels made from coal in 2000 will be pipeline quality high Btu gas, indistinguishable from natural gas and suitable for use in homes and businesses (see Figure 59). The remainder will be refined solid coal (a clean-burning solid produced by removing the sulfur and ash from coal), coal liquids (produced by adding hydrogen to coal at high temperatures and pressures), and low Btu gas (used mainly to produce electricity).[154]

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*If losses in hydroelectric and geothermal generation, metallurgical coal, lube oils and waxes, asphalt and road oil, and field use of natural gas are considered, the gross energy input would total 157 quadrillion Btu's in the year 2000.

The basis for estimating these energy supply patterns is solely economic. The computer model simulates the economic decisions of energy suppliers and consumers. Although some environmental costs are included in the calculations—for example, the costs of environmental control technology—other environmental aspects of energy supply must be evaluated without benefit of computer models. These are the damage costs (as defined in Chapter 4 on Economics) that have not been quantified and entered into the model. They include primary impacts of pollution from energy supply activities and secondary socioeconomic impacts.

To forecast the impacts of any energy program, whether resource development or research and development, three projections must be made:

- Primary environmental impacts, that is, the air and water emissions, the solid wastes, the land requirements of a plant or process, and effects on ecosystems of the area
- The economics of the plant or process
- Secondary environmental impacts of the development—impacts from associated industries, employment, population shifts, housing, public and commercial services and social changes.

All three of the projections must be integrated into a broad overall analysis.[155] Choices among emerging energy technologies must rest upon this kind of analysis.

SYNTHETIC FUELS

Primary Impacts

No commercial size synthetic fuels facility now exists in the United States. We can do no more than estimate air and water emissions, solid wastes, and land requirements.[156] Although the estimates are based on small-scale and pilot plant data, they are useful in planning further research and development.

Some important environmental factors are shown in Table 28 for low Btu coal gasification, high Btu coal gasification, coal liquefaction, and oil shale processing. For each coal conversion process, data for two coal feedstocks are shown: a low sulfur western coal and a high sulfur Illinois coal. An output of 1 trillion Btu's per day is assumed for each case—which is the equivalent of the energy output of four high Btu gasification plants, each with a capacity of 250

Figure 58

Projected U.S. Energy Supplies, 1975-2000

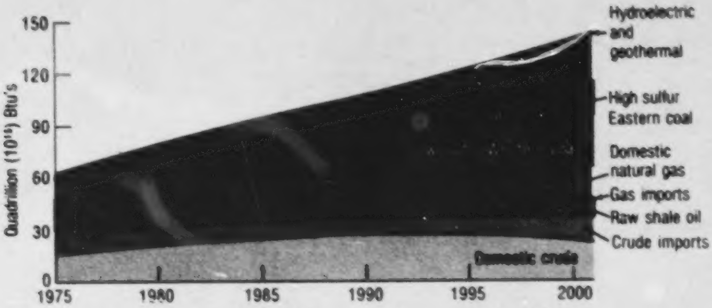
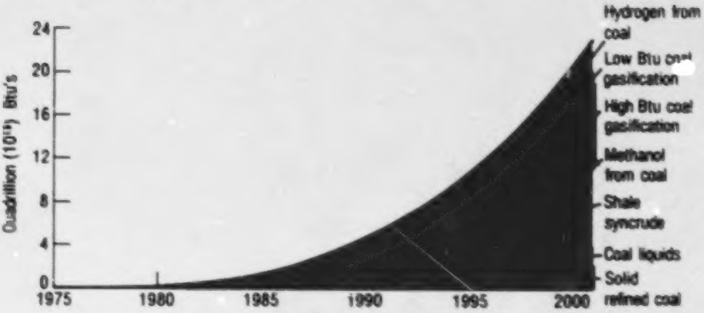


Figure 59

Projected Synthetic Fuel Mix, 1975-2000



Source: Synfuels Interagency Task Force, "Recommendations for a Synthetic Fuels Commercialization Program," Vol. II, "Cost/Benefit Analysis of Alternate Production Levels," draft report to the President's Energy Resources Council, June 1975.

million cubic feet per day; 3.5 oil shale plants, each with a capacity of 50,000 barrels per day; or 3.5 coal liquefaction plants, 50,000 barrels per day.[187]

There are no water emissions in any of the synthetic fuel facilities because total water reuse systems are assumed. As for air emissions, Table 28 shows that nitrogen oxides and hydrocarbons are virtually the same for eastern and western coal but differ according to the coal process used.

Sulfur oxide emissions are a function not only of the process but also of the type of coal feedstocks. With high Btu gasification, high sulfur Illinois coal produces about six times as much sulfur oxide as low sulfur western coal. In a low Btu gasification plant, the Illinois coal emits about four times as much sulfur oxide as the western coal.

Decisions on which coal or which technology to choose are not simple; the options and tradeoffs are numerous. For example, low

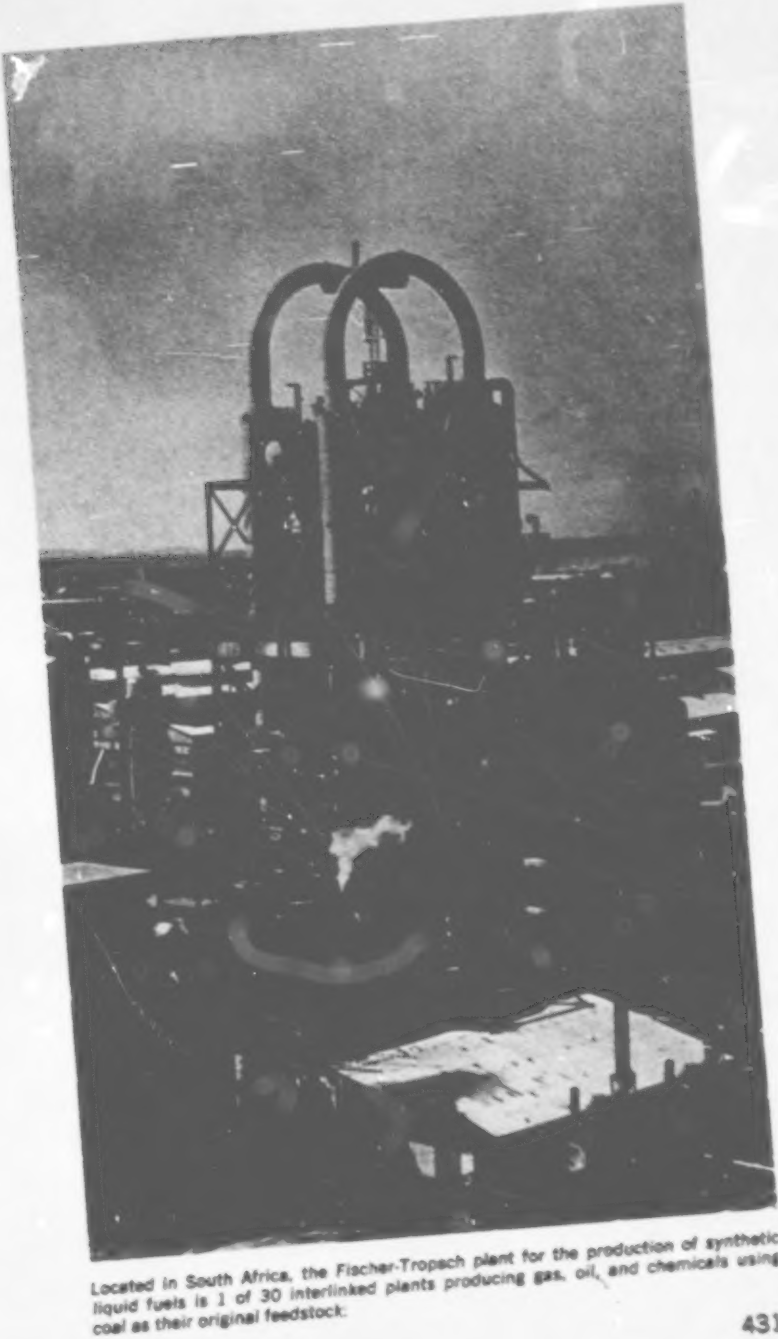
Table 28

Environmental Factors for Some Emerging Energy Technologies [1]

	Low Btu gasification		High Btu gasification		Coal liquefaction		Oil shale Colorado
	Western coal	Illinois coal	Western coal	Illinois coal	Western coal	Illinois coal	
Air (lb/h)							
Particulates	0.86	0.86	727	944	633	612	453.6
SO_2	580	2,250	1,800	10,400	1,493	1,957.7	5,324.1
NO_x	1,130	1,130	7,110	7,770	8,507.5	8,507.5	1,966.7
CO	32.3	32.3	377	414	340	340	174.5
HC	32.6	32.5	115	126	2,607.6	2,607.6	2.652.3
NH_3	56.8	45.4	34.7	54.7	—	—	—
Water (lb/h)							
Suspended solids	0	0	0	0	0	0	0
Dissolved solids	0	0	0	0	0	0	0
Organic material	0	0	0	0	0	0	0
Thermal (Btu/h)	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Solid wastes (ton/day)	5,350	7,320	5,560	7,930	5,519	8,423	164.3×10^3
Land use (acres)	3,190	3,190	1,400	1,400	3,254	3,254	2,000
Water requirements (gal/day)	7.46×10^6	7.46×10^6	64.2×10^6	64.2×10^6	33.3×10^6	33.3×10^6	21.1×10^6
Occupational health (per year)							
Deaths	0.71	0.71	1.8	1.8	0.511	0.511	0.755
Injuries	14.2	14.2	61	61	9.9	9.9	79.2
Man-days lost	7,500	7,500	16,600	16,600	2,372	2,372	77.0
Efficiency (percent)							
Primary product efficiency	75.8	75.8	68.2	67.9	62.5	62.5	66.7
Total products efficiency	86.5	83.9	68.2	67.9	62.5	62.5	79.7
Overall efficiency	86.5	83.9	68.2	67.9	62.5	62.5	76.9
Ancillary energy (Btu/day)	0	0	0	0	0	0	5.59×10^{10}

[1] On the basis of a 10^{11} Btu/day output from each process.

Source: Radian Corporation, *A Western Regional Energy Development Study: Primary Environmental Impacts*, Vol. 2, prepared for the Council on Environmental Quality and the Federal Energy Administration under contract no. EQ4AC037 (Springfield, Va.: National Technical Information Service, 1975).



Located in South Africa, the Fischer-Tropsch plant for the production of synthetic liquid fuels is 1 of 30 interlinked plants producing gas, oil, and chemicals using coal as their original feedstock.

Btu gasification is the process that minimizes sulfur oxide emissions for western coal. For Illinois coal, liquefaction produces about 12 percent less sulfur dioxide than low Btu gasification. For both coals, however, hydrocarbon emissions are eighty-fold higher for liquefaction than for low Btu gasification; they are twenty-fold higher with high Btu gasification than with liquefaction. The complex relationships of feedstocks and technology must be weighed together with state and local air quality standards in deciding location, technology, and type of coal. Land use, water requirements, and other factors should help guide the decision as well.

Considered by themselves, the new technologies do not present a complete picture. For each process the raw coal or shale feed must be extracted from the ground, and often it must be transported to the processing facility. In many cases the synthetic fuel is only an intermediate product that must be further refined or converted before it is ready for final use. Thus, entire chains comprised of links—such as coal extraction, gasification, and transmission—must be considered in comparing the environmental profiles of new energy systems.

Table 29 makes such a comparison. It groups a number of chains by end use categories: electricity, liquid fuels, and gas. The fuel chain comparisons reveal some interesting differences from the single technology comparisons shown in Table 28. Compare, for example, low Btu coal gasification combined with subsequent electric power generation for both western coal and Illinois coal. The particulate emissions for the gasification step itself are equal for both coals, as shown in Table 28. But the total chain involving Illinois coal results in more than twice as many particulate emissions as the western coal chain because of particulates emitted during mining (Table 29, lines 3 and 4). Western coal deposits lie in thicker seams than Illinois coal. Therefore, more earth must be removed to mine 1 ton of coal in Illinois than in the west. On the other hand, hydrocarbons are nine times greater for the scenario involving western coal because the coal is delivered to Chicago by railroad powered by diesel fuel. For Illinois coal, there is a powerplant at the mine mouth, from which electricity is transmitted to Chicago.

The immense amount of solid waste from surface processing of shale oil is 20 to 30 times greater than the solid waste from liquefying coal. Clearly, large-scale mining of oil shale will require development of effective waste management techniques.

As Table 29 shows, the petroleum production, pipeline transportation, and refining chain is less polluting than shale oil and liquids from coal (Table 29, line 8). It produces lower air emissions in every category. Solid waste, land use, and water requirements are also lower and energy efficiency is higher. Strong implications for the focus of energy research and development emerge from the comparison. Enhanced crude oil recovery techniques, for example, may present a very favorable potential when compared with alternatives for producing

Table 29

Environmental Factors for Some Energy Systems [1]

Line No.	End use	Air emissions (pounds/hour)					Solid waste (tons/day)	Land use (acres)	Water required (gallons/day)	Energy efficiency (percent)
		Particulates	SO_x	NO_x	CO	HC				
	Electricity									
1	Surface coal mine (Montana)									
	Rail to Chicago									
	Coal-fired powerplant (Chicago)									
	Total for scenario	9,919	127,812	106,707	15,527	3,329	10,480	50,311	117x10⁶	36
2	Surface coal mine (Montana)									
	Slurry pipeline to Chicago									
	Coal-fired powerplant (Chicago)									
	Total for scenario	8,290	124,033	84,950	4,973	1,482	9,130	41,992	149x10⁶	36
3	Surface coal mine (Montana)									
	Rail to Chicago									
	Low Btu gasification (Chicago)									
	Low Btu gas powerplant (Chicago)									
	Total for scenario	6,671	16,907	99,912	16,321	2,776	16,230	66,640	137x10⁶	28
4	Surface coal mine (Illinois)									
	Low Btu gasification (mine mouth)									
	Low Btu gas powerplant (mine mouth)									
	Long distance transmission to Chicago									
	Total for scenario	14,416	65,736	72,803	2,532	302	20,203	79,101	140x10⁶	28
5	Oil well (Gulf coast)									
	Pipeline to Chicago									
	Refine (Chicago)									
	Oil-fired powerplant (Chicago)									
	Total for scenario	1,284	24,743	89,129	4,081	11,400	9,940	25,708	161x10⁶	33

See footnotes at end of table.

Table 29—Continued

Environmental Factors for Some Energy Systems [1]

Line No.	End use	Air emissions (pounds/hour)					Solid waste (tons/day)	Land use (acres)	Water required (gallons/day)	Energy efficiency (percent)
		Particulates	SO_x	NO_x	CO	HC				
	Liquid fuels									
6	Surface oil shale mine (Colorado) Retort (mine mouth) Crude pipeline to Chicago Refine (Chicago)									
	Total for scenario	1,923	6,099	4,541	858	6,016	185,362	20,135	38×10^6	68
7	Surface coal mine (Montana) Liquefaction (mine mouth) Crude pipeline to Chicago Refine (Chicago)									
	Total for scenario	2,804	3,309	13,549	1,333	7,475	6,792	15,218	57×10^6	52
8	Oil well (Gulf coast) Crude pipeline to Chicago Refine (Chicago)									
	Total for scenario	427	1,029	2,041	597	3,154	3	7,725	11×10^6	93
9	Surface coal mine (Illinois) Rail to Chicago Liquefaction (Chicago) Refine (Chicago)									
	Total for scenario	8,359	4,353	15,725	2,316	7,657	11,148	32,368	57×10^6	47

	Gas									
10	Surface coal mine (Montana)									
	High Btu gasification (mine mouth)									
	Gas pipeline to Chicago									
	Total for scenario	2,780	3,876	19,199	6,272	1,148	5,560	9,827	64×10^{6}	65
11	Surface coal mine (Illinois)									
	High Btu gasification (mine mouth)									
	Gas pipeline to Chicago									
	Total for scenario	6,073	10,424	8,017	618	165	7,930	15,252	64×10^{6}	61
12	Gas well (Gulf coast)									
	Gas pipeline to Chicago									
	Total for scenario	52	166	2,090	59	81,700	0	16,892	0	96

[1] On the basis of a 10^{12} Btu per day output from the trajectory.

Source: Radian Corporation, *A Western Regional Energy Development Study: Primary Environmental Impacts*, Vol. II, prepared for the Council on Environmental Quality and the Federal Energy Administration under contract no. EQ4AC037 (Springfield, Va.: National Technical Information Service, 1975), PB-246 265.

synthetic liquid fuels such as coal liquefaction and shale oil. Additional energy chains are compared within the context of energy facilities siting decisions in Chapter 4.

General estimates of primary environmental factors (emissions, effluents, solid wastes, etc.) are helpful for long-range planning, but studies of pollutants and resource requirements for specific sites are also essential. Site-specific analysis of primary impacts together with a projection of secondary impacts will give decisionmakers a picture of the full environmental consequences of proposals for siting energy facilities and for research and development programs.

Secondary Impacts

An example of secondary impacts may be found in increased western mining activity. Equipment suppliers might open new offices and fabrication plants in the west. A newly built coal liquefaction plant could attract a petrochemicals industry based on coal liquids as a feedstock.

The induced activity causes additional direct environmental impacts (pollution, land and water use, and the like). Large, new plants also require workers for construction and operation. The workers and their families need homes, schools, stores, roads, sewers, water supplies, and the whole gamut of community services. In an already urbanized area the newcomers and their demands would very likely be served by existing or somewhat expanded public facilities. But in remote, unpopulated areas where many new energy plants are likely to be built, the influx of people and their impact on a local economy will be marked. Without adequate planning and preparation, a locality may be disrupted. In fact, the population influx may create greater land use impacts and place higher demands on public services than the energy facility that began the process.[186] In some cases it may generate more air and water pollution as well.

The secondary impacts of a 50,000 barrel per day oil shale surface processing facility would be considerable (see Table 30). How serious these impacts may be depends upon the character of the community. Its pre-existing physical structure and social services and their potential for expansion are among the determining factors. Another important consideration is whether impacted communities can raise the funds for planning and expanding facilities before expanded tax revenues are available. Related discussion may be found in the Chapter 2 section on the coastal zone.

Shale Oil—An Example

As described in the previous section, shale oil is one of several synthetic fuels under consideration for development and demonstration between now and 1985. SRI estimates that 6.4 quadrillion Btu's of energy will be supplied by shale oil by 2000. Although there are shale deposits in a number of states, the rich deposits containing between

Table 30

Estimated Socioeconomic Impact of a 50,000 Barrel per Day Surface Shale Oil Facility[1]

Population and services	Construction	Operation
Population[2]		
Direct labor force	1,827	1,430
Total associated population	13,642	10,648
Energy consumption (trillions of Btu/year)	1.7	1.3
Land required (acres)	2,700	2,100
Water consumption (millions of gal/day)	2.0	1.6
Air pollution (ton/year)	510	400
Water pollution (ton/year)	2,600	2,000
Public investment costs (millions of dollars)[3]	41	16
Public annual operating and maintenance costs (millions of dollars)	8.0	6.3

[1] The table represents typical national conditions; numbers would have to be adjusted before being applied to a specific site. Except as noted, data are derived from Real Estate Research Corporation, *The Costs of Sprawl: Detailed Cost Analysis*, prepared for the Council on Environmental Quality, U.S. Department of Housing and Urban Development, and Environmental Protection Agency under Contract No. EQ4AC039 (Washington, D.C.: Government Printing Office, 1974).

[2] Synfuels Interagency Task Force, "Recommendations for a Synthetic Fuels Commercialization Program," Vol. IV, "Preliminary Draft Environmental Impact Statement," report to the President's Energy Resources Council, June 1975.

[3] OMB estimates; the two columns are additive.

25 and 100 gallons of oil per ton of shale are concentrated in Colorado, Utah, and Wyoming.[159] A shale industry capable of providing the 6.4 quadrillion Btu's by 2000 might include some 30 plants, each capable of producing 100,000 barrels per day, which is double the capacity of a prototype facility.[160]

Table 31 shows a number of the direct environmental effects of an industry of this size. Some of the quantities are enormous. Solid wastes would be almost nine times the total U.S. residential and commercial postconsumer solid wastes volume in 1973[161] (see the Solid Wastes section in Chapter 2). The daily water requirement of 417 million gallons is enough to supply the daily household needs of the entire population of the Washington, D.C., metropolitan area.[162] Sulfur dioxide emissions would equal those from thirteen 1,000 megawatt powerplants burning low sulfur western coal without any emission controls.[163]

Clearly these figures do not tell the whole story. Good plant siting practices and favorable atmospheric conditions can mitigate air pollution. Integrating solid waste disposal with mining can ameliorate the waste problem. For the most part, environmental problems must be examined on a case-by-case basis. However, the sheer magnitude of the figures indicates where future environmental problems will almost certainly be and strongly points toward research and development to prevent and control them.

Table 31

Estimated Environmental Factors for a 3 Million Barrel per Day Shale Oil Industry

Environmental factor	Amount
Air pollutants (tons/day)	
Particulates	361
Sulfur oxides	1,264
Nitrogen oxide	479
Carbon monoxide	49
Hydrocarbons	631
Water pollutants [1]	—
Solid waste (millions of tons/day)	3.25
Land use (thousands of acres)	234
Water requirements (millions of gallons/day)	417
Ancillary energy (trillions of Btu's/day)	1.15

[1] Total water reuse system assumed.

Source: Radian Corporation, *A Western Regional Energy Development Study: Primary Environmental Impacts*, Vol. 1, prepared for the Council on Environmental Quality and the Federal Energy Administration under contract no. EQ4AC037 (Springfield, Va.: National Technical Information Service, 1975).

Ecological problems arise in all phases of oil shale development—construction, operation, land rehabilitation, and closing down after the resource is exhausted. Changes in land and water use can destroy and damage plant and animal life, especially rare and endangered species, four of which have been identified in a Colorado tract under study.[164] Ecologists have questioned the influence of major water system changes on the incidence of disease-carrying mosquitoes. Aquatic food chains may suffer from the increased salinity and siltation that are likely to result from diverting water for oil shale processing. Effects of water diversion would ultimately cover entire basins, and jurisdictional disputes over water rights are anticipated.

CONTINUING EVALUATION

As part of its continuing responsibility under Section 11 of the Federal Nonnuclear Energy Research and Development Act of 1974,[165] CEQ will be reporting on other nonnuclear energy technologies in future Annual Reports, and attempts will be made to predict more accurately the impacts on ambient conditions, secondary impacts, and implications for energy transportation.

ENVIRONMENTAL DATA

If you were a city official concerned with urban air pollution, you might well need data on such diverse subjects as motor vehicle use, population, fuel production and consumption, and economics. Similarly, if you were a regional planner, you would need information on all these topics, plus land use, industrial activities, water resources, agriculture, housing trends, and many more. The environment is measurable in many different terms—the scientific, technological, demographic, economic, and social.

However diffuse, most of these data are generally available, but it is often very difficult to learn what authoritative statistics there are and where and how to obtain them efficiently. This is a problem to the private citizen, public policymaker, and environmental specialist alike.

Because many CEQ activities regularly involve the acquisition and review of diverse environmental data, a National Academy of Sciences planning committee recently recommended that the Council issue an "annual referenced compendium of environmental statistics."[169] A concise, categorized, annual summary of data on environmental trends and their components and causes would be a useful and convenient interdisciplinary statistical reference.

Sometimes well-selected and -displayed data themselves best indicate environmental conditions and trends. In other cases, it is necessary to survey and assess the data in order to derive quantitative indices and indicators.

CEQ is presently conducting or sponsoring several projects that involve interdisciplinary data bases and the reporting of their summary data. These efforts are directed in part toward the annual publication of a national environmental statistics report that is fully referenced, annotated, and cross-indexed. As the projects progress, we expect to become more aware of gaps and duplications in the nation's environmental data bases. The following tables are a representative selection of the topics to be included in the report.

Table 32

Nationwide Air Pollution Emissions, by Pollutant and Source, 1970–74[1]

(In millions of tons per year)

Pollutants and sources	1970	1971	1972	1973	1974
Particulates					
Transportation[2]	1.2	1.2	1.3	1.3	1.3
Fuel combustion in stationary sources	8.3	7.5	7.1	6.4	5.9
Industrial processes[3]	15.7	14.5	13.1	11.9	11.0
Solid waste disposal	1.1	0.8	0.7	0.6	0.5
Miscellaneous[4]	1.2	1.2	1.0	0.8	0.8
Total	27.5	25.2	23.2	21.0	19.5
Sulfur oxides					
Transportation[2]	0.7	0.7	0.7	0.8	0.8
Fuel combustion in stationary sources	27.0	26.7	25.2	25.6	24.3
Industrial processes[3]	6.4	6.0	6.6	6.7	6.2
Solid waste disposal	0.1	0.0	0.0	0.0	0.0
Miscellaneous[4]	0.1	0.1	0.1	0.1	0.1
Total	34.3	33.5	32.6	33.2	31.4
Carbon monoxide					
Transportation[2]	82.3	80.9	83.4	79.3	73.5
Fuel combustion in stationary sources	1.1	1.0	1.0	1.0	0.9
Industrial processes[3]	11.8	11.6	12.0	13.0	12.7
Soid waste disposal	5.5	3.9	3.2	2.8	2.4
Miscellaneous[4]	6.6	7.5	5.3	4.8	5.1
Total	107.3	104.9	104.9	100.9	94.6
Hydrocarbons					
Transportation[2]	14.7	14.3	14.1	13.7	12.8
Fuel combustion in stationary sources	1.6	1.7	1.7	1.7	1.7
Industrial processes[3]	2.9	2.7	2.9	3.1	3.1
Solid waste disposal	1.4	1.0	0.8	0.7	0.6
Miscellaneous[4]	11.5	11.7	11.8	12.1	12.2
Total	32.1	31.4	31.3	31.3	30.4
Nitrogen oxides					
Transportation[2]	9.3	9.8	10.5	11.0	10.7
Fuel combustion in stationary sources	10.1	10.1	10.8	11.2	11.0
Industrial processes[3]	0.6	0.6	0.6	0.6	0.6
Solid waste disposal	0.3	0.2	0.2	0.1	0.1
Miscellaneous[4]	0.1	0.1	0.1	0.1	0.1
Total	20.4	20.8	22.2	23.0	22.5

[1] The data presented in this table are estimates based on common data sources, uniform estimation methods, and consistent assumptions. At the time these estimates were prepared, most 1974 and some 1973 source data were not available from the standard references. Missing items were projected on the basis of forecasts from industrial trade journals, economic indications, or extrapolations from 1967–72 data.

[2] Includes all highway motor vehicles and all off-highway mobile sources such as aircraft, railroads, vessels, and agricultural, industrial, and construction machinery.

[3] Emissions for over 80 industrial processes/products were computed, including all major operations known to emit more than 10,000–20,000 tons per year of some criteria pollutant on a national scale.

[4] Sources not appropriately classified under previous categories are included here. Among these are forest fires, coal refuse burning, organic solvents, and oil and gasoline production.

Source: Environmental Protection Agency.

Table 33

Air Quality Monitoring Stations at Which Ambient Standards Were Exceeded, 1969–73

Status	Number of monitoring stations				
	1969	1970	1971	1972	1973
Suspended particulates					
Total stations with 1 year of valid data	667	644	640	1,589	1,300
Exceeding annual secondary standard	638	459	426	871	657
Exceeding annual primary standard	335	319	275	516	341
Total stations with 1 or more quarters of valid data	1,095	1,002	1,313	2,683	3,380
Exceeding 24-hour secondary standard	594	530	628	1,100	1,222
Exceeding 24-hour primary standard	184	161	140	261	303
Sulfur dioxide					
Total stations with 1 year of valid data	178	155	153	500	457
Exceeding annual primary standard	24	19	4	9	14
Total stations with 1 or more quarters of valid data	234	276	409	1,064	1,623
Exceeding 24-hour secondary standard	72	52	60	NA	NA
Exceeding 24-hour primary standard	54	34	47	24	40
Carbon monoxide					
Total stations with 1 or more quarters of valid data	35	48	58	128	212
Exceeding 1-hour standard	3	10	7	13	24
Exceeding 8-hour standard	29	39	53	95	153
Total oxidants or ozone					
Total stations with 1 or more quarters of valid data	38	45	50	111	187
Exceeding 1-hour standard	37	43	50	93	162
Nitrogen dioxide					
Total stations with 1 or more quarters of valid data	NA	NA	NA	NA	588
Total stations with 1 year of valid data	NA	NA	NA	NA	54
Exceeding annual standard	NA	NA	NA	NA	9

NA = Not available.

Source: Environmental Protection Agency, *The National Air Monitoring Program: Air Quality and Emissions Trends Annual Report*, Volume II, EPA–450/1–73–001b (Washington, D.C.: Government Printing Office, 1973); Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1972*, EPA–450/1–73–004 (Washington, D.C.: Government Printing Office, 1973); Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1973*, EPA–450/1–74–007 (Washington, D.C.: Government Printing Office, 1974).

Table 34

Air Quality Control Regions Reporting Violations of Ambient Standards, 1969–73

Violations	1969	1970	1971	1972	1973
Suspended particulates					
Reporting 1 or more valid station-year	149	143	135	191	172
Exceeding annual secondary guide	113	117	104	157	139
Exceeding annual primary standard	88	97	87	122	99
Reporting 1 or more valid station-quarters	180	173	181	218	225
Reporting only valid quarters	31	30	46	27	53
Exceeding 24-hour secondary standard	122	113	128	171	188
Exceeding 24-hour primary standard	66	65	63	99	115
Exceeding either secondary standard or guide	138	134	143	185	193
Exceeding either primary standard	105	106	100	138	143
Reporting insufficient data to compare with standards	67	74	66	29	22
Sulfur dioxide					
Reporting 1 or more valid station-year	75	70	65	123	100
Exceeding annual primary standard	7	7	3	4	10
Reporting 1 or more valid station-quarter	89	88	119	162	187
Reporting only valid quarters	14	44	54	39	87
Exceeding 24-hour primary standard	15	13	26	19	17
Exceeding 3-hour secondary standard	7	5	7	7	8
Exceeding either primary standard	17	16	26	19	22
Reporting insufficient data to compare with standards	158	135	128	85	59
Carbon monoxide					
Reporting 1 or more valid station quarter	16	14	21	48	60
Exceeding any primary standard	14	14	21	42	[1] 10.53

See footnotes at end of table.

Table 34—Continued

Air Quality Control Regions Reporting Violations of Ambient Standards, 1969–73

Violations	1969	1970	1971	1972	1973
Oxidants					
Reporting 1 or more valid station-quarter	9	13	15	38	57
Exceeding any primary standard	9	12	15	28	[2] 51
Nitrogen dioxide					
Reporting 1 or more valid station-quarter	NA	NA	NA	NA	132
Reporting 1 or more valid station-year	NA	NA	NA	NA	20
Exceeding any primary standard	NA	NA	NA	NA	2

NA=Not available

[1] Exceeding 1-hour standard, exceeding 8-hour standard.

[2] Exceeding 1-hour standard.

Source: Environmental Protection Agency, *The National Air Monitoring Program: Air Quality and Emissions Trends Annual Report*, Volume I, EPA–450/1–73–001b (Washington, D.C.: Government Printing Office, 1973); Environmental Protection Agency, *Monitoring and Air Quality Trends Report*, 1972, EPA–450/1/73–004 (Washington, D.C.: Government Printing Office, 1973); Environmental Protection Agency, *Monitoring and Air Quality Trends Report*, 1973, EPA–450/1–74–007 (Washington, D.C.: Government Printing Office, 1974).

Table 35

Municipal Waste Water Treatment Facilities, by Treatment Level and State, 1974

State	Total	Primary[1]	Adequate secondary[2]	Inadequate secondary[2]	Unclassified secondary[3]	Tertiary[4]	None
Alabama	261	32	65	42	101	0	21
Alaska	38	8	0	1	25	0	4
Arizona	119	3	7	13	75	1	20
Arkansas	211	18	5	29	157	0	2
California	659	119	69	62	375	11	23
Colorado	233	11	15	16	168	7	16
Connecticut	180	39	11	7	84	6	33
Delaware	25	5	8	8	2	0	2
District of Columbia	1	0	0	1	0	0	0
Florida	582	40	173	147	189	14	19
Georgia	474	64	207	114	62	2	25
Hawaii	39	5	9	3	15	0	7
Idaho	129	17	16	42	37	0	17
Illinois	828	71	183	230	287	31	26
Indiana	741	43	37	80	355	104	122
Iowa	639	27	23	122	350	0	117
Kansas	632	98	13	67	442	0	12
Kentucky	284	25	6	5	238	3	7
Louisiana	188	11	1	2	159	0	15
Maine	68	15	4	3	24	0	22
Maryland	304	28	61	57	141	0	17
Massachusetts	156	37	0	0	77	0	39
Michigan	482	108	59	58	132	13	112
Minnesota	520	53	15	92	311	15	34
Mississippi	312	7	4	11	277	0	13
Missouri	454	20	18	31	376	0	9
Montana	163	24	2	2	127	2	6
Nebraska	496	41	4	24	385	7	35
Nevada	39	3	7	2	24	1	2

New Hampshire	45	18	0	2	23	0	2
New Jersey	339	84	20	33	193	4	5
New Mexico	82	1	8	27	45	0	1
New York	747	472	34	66	135	16	24
North Carolina	1,156	114	150	166	634	33	59
North Dakota	256	15	3	11	216	0	11
Ohio	1,033	89	219	123	298	132	172
Oklahoma	385	12	76	157	137	0	3
Oregon	249	42	39	54	91	2	21
Pennsylvania	1,877	164	429	263	494	253	274
Rhode Island	27	8	1	7	2	2	7
South Carolina	1,416	113	37	93	1,067	82	24
South Dakota	227	19	93	74	26	2	13
Tennessee	265	17	60	42	134	6	6
Texas	911	73	172	490	171	1	4
Utah	89	14	23	21	17	1	13
Vermont	79	34	1	4	31	0	9
Virginia	956	99	54	90	673	22	18
Washington	363	95	22	39	182	2	23
West Virginia	578	149	6	10	385	5	23
Wisconsin	562	84	101	195	132	14	36
Wyoming	85	9	0	2	70	1	3
United States	21,065	2,723	2,575	3,287	10,153	795	1,532

[1] Primary treatment plants take raw sewage and separate the particulate matter from the water by settling the heavier solids and skimming off the lighter ones. This process normally removes 20 to 35 percent of the BOD_5 (5-day biochemical oxygen demand, determined by incubating a sample in a bottle at 20°C for 5 days, and then measuring the amount of oxygen metabolically consumed by the microorganisms).

[2] Secondary treatment plants use biological degradation to treat output from primary treatment. Under the 1972 Federal Water Pollution Control Act amendments, EPA requires by July 1977 that publicly owned treatment works achieve BOD_5 effluent concentrations of 30 mg/l and at least 85 percent BOD_5 removal. Facilities achieving these levels are considered adequate secondary treatment facilities. Those not achieving these concentrations are classified as inadequate secondary treatment facilities.

[3] Data insufficient for further classification.

[4] Tertiary treatment plants apply various types of additional treatment to the effluent from the secondary system. These additional processes often involve nutrient (nitrogen or phosphous) removal and can achieve BOD_5 effluent concentrations significantly lower than secondary treatment.

Source: Environmental Protection Agency, *National Water Quality Inventory: 1974 Report to the Congress*, Vol. I, EPA–440/9–74–001 (Washington, D.C.: Government Printing Office, 1974).

Table 36

Polluting Spills Reported in U.S. Waters, 1971–74

Spills, by category [1]	Number of incidents				Total volumes in gallons			
	1971	1972	1973	1974	1971	1972	1973	1974
Type of location								
Inland waters	631	682	1,722	2,815	1,409,867	2,270,771	7,117,239	9,585,437
Coastal waters	7,201	7,442	9,871	9,503	6,720,259	14,277,675	15,490,447	8,361,932
Open waters (Great Lakes or territorial seas)	315	423	571	251	37,736	24,681	419,428	108,216
Contiguous zone (from 3 to 12 miles from coastline)	396	801	483	164	651,177	34,793	1,218,860	24,706
High seas	193	583	681	1,233	20,484	2,197,812	68,944	52,347
Type of pollutant								
Light oil [2]	4,320	4,290	4,104	2,657	2,822,463	6,578,653	6,415,242	3,181,561
Heavy oil [3]	1,603	2,049	2,851	5,084	2,934,181	1,761,301	4,538,127	12,754,816
Solvent	(4)	(4)	49	44	(4)	(4)	32,469	13,114
Waste oil	930	890	1,003	1,094	164,352	8,067,043	1,211,131	111,900
Other oil	669	1,151	2,996	2,774	2,714,399	357,724	2,650,169	820,694
Other materials (including sewage, refuse, etc.)	269	428	[illegible]	470	115,042	2,025,897	8,339,714	1,193,737
Unknown	945	1,123	[illegible]	1,843	89,085	15,114	1,128,066	56,816
Source								
Vessels								
Dry cargo vessels	271	402	353	377	418,206	42,771	650,409	90,987
Tank ships	386	453	825	973	1,665,264	2,583,952	4,494,524	1,434,168
Tank barges	828	830	718	833	1,197,819	3,739,144	1,572,059	2,468,724
Combatant vessels	261	294	246	278	440,849	40,923	17,963	39,552
Other vessels	388	494	1,408	1,265	180,127	96,508	1,184,754	253,007

Land vehicles	77	145	305	373	101,225	172,519	741,588	785,548
Nontransportation-related facilities, refineries	188	185	214	155	2,206,781	42,027	166,403	772,634
Pipelines	(5)	216	559	557	(5)	1,237,227	1,847,498	6,205,372
Other land transportation facilities	22	68	162	3,489	159,961	13,331	151,285	2,695,472
All other onshore and offshore facilites [6]	3,723	3,804	3,904	799	2,158,718	10,483,247	6,479,453	1,567,551
Miscellaneous and unknown	2,592	3,040	4,634	4,867	310,573	354,083	[7] 7,009,252	1,819,623
Cause								
Casualty (includes collision, grounding, and blowouts)	214	360	[8] 2,793	952	3,045,719	4,082,094	[8] 16,068,447	4,861,431
Rupture, leak, or structural failure	2,757	2,201		2,352	3,715,067	4,823,322		7,234,937
Equipment failure (valves, pumps)	947	1,542	1,872	2,103	274,049	293,755	800,540	1,100,005
Personnel failure	829	1,287	2,204	2,707	1,035,950	940,316	1,127,851	3,544,576
Deliberate discharges	359	457	599	316	50,652	68,515	2,176,509	292,193
Natural phenomenon	94	257	354	380	5,805	8,045,972	2,051,364	241,410
Unknown	3,536	3,827	5,506	5,156	712,281	551,758	2,090,207	858,086
Total spills reported	8,736	9,931	13,328	13,966	8,839,523	18,805,732	24,314,918	18,132,638

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[1] The U.S. Coast Guard has no reason to believe that the number of discharges in 1973 was any greater than in 1971 or 1972. The increase in the number reported probably reflected public awareness of the legal requirement to report discharges.

[2] Data for 1971 and 1972 include gasoline, light fuel oil, kerosene, and light crude; 1973 data include crude oil, gasoline, and other distillate fuel oil.

[3] Data for 1971 and 1972 include diesel oil, heating oil, heavy fuel oil, heavy crude, and asphalt; 1973 data include diesel oil, asphalt, and residual fuel oil.

[4] Data for 1973 added the category of solvents, previously included under several other categories.

[5] Pipeline data for 1971 are included under other categories.

[6] Changes in 1973 "sources" categories make it necessary to combine some onshore and offshore production, storage, and transfer facilities in order to compare data to those for 1971 and 1972.

[7] Includes one 6-million-gallon sewage spill.

[8] Changes in 1973 "cause" categories make it necessary to combine the categories of "casualty" and "rupture, leak, or structural failure."

Source: U.S. Department of Transportation, U.S. Coast Guard, "Polluting Incidents in and Around U.S. Waters," annual (Washington, 1971, 1972, 1973); U.S. Coast Guard, unpublished data.

Table 37

Pollution-Caused Fish Kills, 1965–73

	1965	1966	1967	1968	1969	1970	1971	1972	1973[1]
Number of states responding	44	46	40	42	45	45	46	50	50
Number of reports	625	532	454	542	594	635	860	760	749
Reports which state number of fish killed	520	453	364	469	492	563	759	697	703
Total reported number of fish killed, in thousands	12,140	9,614	11,291	15,815	41,166	22,290	73,670	17,717	57,314
Average size of kill[2]	4,310	5,620	6,460	6,015	5,860	6,412	6,154	4,639	5,527
Largest kill reported, in thousands	3,000	1,000	6,549	4,029	26,527	3,240	5,500	2,922	10,000
Number of reported incidents for each pollution source operation									
Agricultural	114	88	87	77	117	108	132	113	161
Industrial	244	195	139	177	199	213	231	189	196
Municipal[3]	125	87	91	122	84	120	162	167	146
Transportation	27	27	23	39	32	28	52	56	65
Other	23	38	35	23	33	28	64	72	56
Unknown	92	97	79	104	129	138	219	163	125
Total reports	625	532	454	542	594	635	860	760	749
Average duration of kill, in days	2.57	2.71	3.34	2.99	3.11	3.25	3.35	3.40	2.72

[1] Preliminary data.

[2] Derived after excluding reports of kills of 100,000 fish or more as unrepresentative.

[3] Municipal operations include electric power-generating stations.

Source: Environmental Protection Agency, *1972 Fish Kills: Thirteenth Annual Report*, EPA-440/9-001 (Washington, D.C.: Government Printing Office, undated); Environmental Protection Agency, unpublished data.

Table 38

Total Acreage and Federally Owned Acreage by State, 1973

(In thousands of acres)

State	Total acreage	Not owned by federal government	Owned by federal government[1]	
			Area	Percent
Alabama	32,678	31,569	1,109	3.4
Alaska	365,482	12,098	353,384	96.7
Arizona	72,688	40,754	31,934	43.9
Arkansas	33,599	30,420	3,179	9.5
California	100,207	55,135	45,072	45.0
Colorado	66,486	42,547	23,939	36.0
Connecticut	3,135	3,126	9	0.3
Delaware	1,266	1,227	39	3.0
District of Columbia	39	29	10	26.2
Florida	34,721	31,295	3,426	9.9
Georgia	37,295	35,090	2,205	5.9
Hawaii	4,106	3,689	417	10.2
Idaho	52,933	19,201	33,732	63.7
Illinois	35,795	35,237	558	1.6
Indiana	23,158	22,683	475	2.1
Iowa	35,860	35,636	224	0.6
Kansas	52,511	51,810	701	1.3
Kentucky	25,512	24,199	1,313	5.1
Louisiana	28,868	27,814	1,054	3.7
Maine	19,848	19,717	131	0.7
Maryland	6,319	6,121	198	3.1
Massachusetts	5,035	4,956	79	1.6
Michigan	36,492	33,100	3,392	9.3
Minnesota	51,206	47,852	3,354	6.6
Mississippi	30,223	28,646	1,577	5.2
Missouri	44,248	42,189	2,059	4.7
Montana	93,271	65,623	27,648	29.6
Nebraska	49,032	48,340	692	1.4
Nevada	70,264	9,432	60,832	86.6
New Hampshire	5,769	5,059	710	12.3

See footnotes at end of table.

Table 38—Continued

Total Acreage and Federally Owned Acreage, by State, 1973

State	Total acreage	Not owned by federal government	Owned by federal government[1]	
			Area	Percent
New Jersey	4,813	4,683	130	2.7
New Mexico	77,766	51,899	25,867	33.3
New York	30,681	30,452	229	0.7
North Carolina	31,403	29,458	1,945	6.2
North Dakota	44,452	42,157	2,295	5.2
Ohio	26,222	25,895	327	1.2
Oklahoma	44,068	42,574	1,514	3.4
Oregon	61,599	29,376	32,223	52.3
Pennsylvania	28,805	28,154	651	2.3
Rhode Island	677	669	8	1.2
South Carolina	19,374	18,233	1,141	5.9
South Dakota	48,882	45,598	3,284	6.7
Tennessee	26,728	24,954	1,774	6.6
Texas	168,218	165,044	3,174	1.9
Utah	52,697	17,831	34,866	66.2
Vermont	5,937	5,667	270	4.5
Virginia	25,496	23,153	2,343	9.2
Washington	42,694	30,118	12,576	29.5
West Virginia	15,411	14,356	1,055	6.8
Wisconsin	35,011	33,204	1,807	5.2
Wyoming	62,343	32,275	30,068	48.2
United States	2,271,343	1,510,344	760,999	33.5

[1] Excludes trust properties.

Source: General Services Administration, *Inventory Report on Real Property Owned by the United States Throughout the World as of June 30, 1973* (Washington, D.C.: Government Printing Office, 1974).

Table 39

Agricultural and Nonagricultural Land Use, 1959–69

(In millions of acres)

Land use	1959	1964	1969
Agricultural			
Cropland	458	444	472
Cropland used for crops	359	335	333
Cropland harvested	317	292	286
Crop failure	11	6	6
Cultivated summer fallow	31	37	41
Soil improvement and idle cropland	33	52	51
Cropland pasture	66	57	88
Grassland pasture and range	633	640	604
Forest land grazed	245	225	198
Farmsteads	8.1	7.3	6.6
Farmroads and lanes	2.1	1.8	1.9
Total agricultural land	1,346.2	1,318.1	1,282.5
Nonagricultural			
Forest land not grazed	501	507	525
Urban and other built up areas	52.5	55.3	60.6
Urban areas [1]	27.2	29.3	34.6
Highways and roads	20.5	21.2	21.0
Railroads	3.4	3.3	3.2
Airports	1.4	1.5	1.8
Recreation and wildlife	61.4	75.5	81.3
National parks	24.2	26.0	28.3
State parks	5.5	5.9	6.7
Wilderness and primitive areas	14.5	14.6	14.3
Federal wildlife refuges	11.5	22.4	25.4
State wildlife refuges	[3] 5.7	6.6	6.6
Public installations and facilities	32.3	33.1	27.5
National defense areas	[2] 24.4	23.6	23.4
Federal industrial lands	1.9	2.1	2.2
State institutional and other uses	1.2	1.3	1.9
Flood control land	4.8	6.1	
Miscellaneous land [4]	277	277	287
Total nonagricultural land	924.2	947.9	981.4
Total land area [5]	2,271	2,266	2,264

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[1] Areas occupied by towns and cities with populations of 1,000 or more.

[2] Includes acreage classified as urban or built-up that was not feasible to separate for the purposes of this publication.

[3] Excludes about 10 million acres of multiple-use forest areas. These areas include land around publicly owned reclamation, flood control, navigation, power, and water-supply reservoirs; county rural parks; and other public areas having recreational facilities.

[4] Includes miscellaneous uses not inventoried, and areas such as marshes, open swamps, bare rock areas, desert, and tundra.

[5] Totals may not add because of rounding.

Source: U.S. Department of Agriculture, *Major Uses of Land and Water in the United States with Special Reference to Agriculture*, Agricultural Economic Reports Nos. 13 and 149 (Washington, D.C.: Government Printing Office, 1962, 1968); U.S. Department of Agriculture, *Major Uses of Land in the United States*, Agricultural Economic Report No. 247 (Washington, 1973).

Table 40

U.S. Pesticide Production, 1968–73

(In thousands of pounds [1])

Pesticide	1968	1969	1970	1971	1972	1973 [2]
Fungicides						
Copper naphthenate	1,718	1,545	1,730	1,695	2,206	1,552
Copper sulfate [3]	37,192	42,072	28,768	31,112	28,064	39,688
Dithiocarbamic acid salts	(4)	(4)	39,381	35,110	40,438	41,417
Ferbam	1,900	[5] 1,500	(4)	(4)	(4)	(4)
Nabam	[5] 2,000	1,938	(4)	(4)	(4)	(4)
Zineb	3,081	[5] 2,500	(4)	(4)	(4)	(4)
Mercury fungicides	1,448	941	1,114	601	547	361
Pentachlorophenol (PCP) [6]	48,575	45,988	47,170	50,877	49,704	46,606
2,4,5-Trichlorophenol and salts	28,066	(4)	(4)	(4)	(4)	(4)
Other organic fungicides	66,793	85,607	50,307	60,875	49,610	63,738
Total [7]	190,773	182,091	168,470	180,270	170,569	193,362
Herbicides						
2,4-D acid [8]	(79,263)	(47,077)	(43,576)	(4)	(4)	(4)
2,4-D acid, esters, and salts	94,116	56,998	(4)	(4)	(4)	(4)
DNEP, ammonium salts	(4)	(4)	(4)	(4)	(4)	(4)
Maleic hydrazide	(4)	2,771	3,271	(4)	4,472	(4)
Methanearsonic acid salts	(4)	(4)	30,454	24,476	30,698	40,126
Phenyl mercuric acetate (PMA) [9]	582	534	457	337	307	290
Silvex	(4)	1,597	2,016	(4)	(4)	(4)
Sodium chlorate [10]	30,000	30,000	30,000	30,000	30,000	30,000
2,4,5-T acid [8]	(17,530)	(4,999)	(4)	(4)	(4)	(4)
2,4,5-T acid, esters, and salts	42,542	11,626	12,335	(4)	(4)	(4)
Other organic herbicides	235,541	268,238	312,132	404,036	416,141	455,693
Total	[3] 499,574	423,840	434,241	458,849	481,618	526,109

Insecticides, fumigants, rodenticides [11]						
Aldrin-toxaphene group [12]	115,974	107,311	88,641	116,264	141,858	145,584
Calcium arsenate	3,398	1,158	1,144	940	(4)	(4)
DDT	139,401	123,103	59,316	(4)	(4)	(4)
Dibromochloropropane	7,887	8,611	(4)	(4)	(4)	(4)
Lead arsenate	9,016	9,204	4,156	6,168	5,164	3,946
Methyl bromide [13]	20,454	20,033	21,047	(4)	24,633	29,571
Organophosphorus insecticides [8]	(4)	(4)	(132,496)	(138,185)	(160,642)	(187,752)
Methyl parathion	38,163	50,572	41,353	37,226	51,076	4[illegible],890
Parathion	[5] 20,000	(4)	15,259	(4)	(4)	(4)
Other	(4)	(4)	75,884	100,959	109,566	138,862
Other organic insecticides	227,326	260,892	188,632	303,261	236,442	276,262
Total	561,619	58[illegible],884	495,532	564,818	568,739	643,115
Total production	[14] 1,271,966	[14] 1,1[illegible]6,815	[14] 1,098,143	1,203,937	1,220,926	1,362,586

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[1] Weight as applied; technical grade, different purities for different compounds.
[2] Preliminary.
[3] Shipments by producers for use in agriculture (including use as a minor plant nutrient).
[4] Withheld to avoid disclosure; figure included in totals.
[5] Estimated.
[6] Not only a wood preservative but also a herbicide and desiccant.
[7] Sulfur not included may amount to 150 million pounds.
[8] Figures in parentheses represent duplication but are included so that totals are comparable with 1971 and 1972 totals.
[9] Also a fungicide.
[10] Estimated shipments to producers of herbicides and defoliants.
[11] Includes a small quantity of synthetic soil conditioners; does not include the fumigants carbon tetrachloride, carbon disulfide, ethylene dibromide, and ethylene dichloride, which have many other uses; nor does it include paradichlorobenzene (classed by the Tariff Commission as an intermediate) or inorganic rodenticides.
[12] Includes aldrin, chlordane, dieldrin, endrin, heptachlor, Strobane (R), and toxaphene.
[13] Fumigant for control of both insects and weeds.
[14] Revised.

Source: D. Lee Fowler and John N. Mahan, *The Pesticide Review: 1973* (Washington, D.C.: U.S. Department of Agriculture, undated); U.S. Department of Agriculture unpublished data.

Table 41

Estimated U.S. Pesticide Use, 1966–71

(In millions of pounds, active ingredient)

Type of pesticide [1]	Total U.S. use			Farm use		
	1966	1971	Percent increase 1966–71	1966	1971	Percent increase 1966–71
Herbidices	227	359	58	125	251	101
Insecticides	329	319	−3	195	201	3
Fungicides	125	155	24	33	42	27
Total	681	833	22	353	494	40

[1] Herbicides include plant growth regulators, defoliants, and desiccants; insecticides include miticides, rodenticides, repellants, and fumigants. Excluded are sulfur, creosote, petroleum oils, and several other pesticides.

Source: U.S. Department of Agriculture, *Quantities of Pesticides Used by Farmers in 1966*, Agricultural Economic Report No. 179 (Washington, D.C.: Government Printing Office, 1970); U.S. Department of Agriculture, *Farmers' Use of Pesticides in 1971: Quantities*, Agricultural Economic Report No. 252 (Washington, D.C.: Government Printing Office, 1974).

Table 42

U.S. Production and Sales of Synthetic Organic Chemicals and Their Raw Materials, 1972–73

Chemical	Production			Sales		
	1972	1973	Increase or decrease (—), 1973 over 1972 [1]	1972	1973	Increase or decrease (—), 1973 over 1972 [1]
	Millions of pounds	Millions of pounds	Percent	Millions of pounds	Millions of pounds	Percent
Tar	7,472	7,325	—2.0	3,409	3,363	—1.3
Tar crudes [2]	7,937	7,802	—1.7	5,304	5,151	—2.9
Crude products from petroleum and natural gas	86,792	91,250	5.1	47,900	49,625	3.6
Synthetic organic chemicals, total [3]	164,218	179,717	9.4	94,205	106,173	12.7
Cyclic intermediates	34,967	35,863	2.6	16,196	17,915	10.6
Dyes	263	284	7.9	255	266	4.6
Organic pigments	66	69	5.3	53	61	15.5
Medicinal chemicals	234	234	—0.3	163	179	9.8
Flavor and perfume materials	110	117	5.9	104	108	4.2
Plastics and resin materials	25,921	30,251	16.7	22,946	27,018	17.7
Rubber-processing chemicals	361	401	11.1	280	312	11.3
Elastomers (synthetic rubbers)	4,914	5,990	21.9	4,136	5,159	24.7
Plasticizers	1,708	1,873	9.7	1,637	1,708	4.3
Surface-active agents	4,039	4,372	8.3	2,258	2,580	14.3
Pesticides and related products	1,158	1,289	11.3	1,022	1,199	17.3
Miscellaneous chemicals	90,476	98,974	9.4	45,155	49,667	10.0
Total [3]	266,419	286,092	7.4	150,818	164,312	8.9

[1] Percentages calculated from figures rounded to thousands.

[2] Estimated in part to avoid disclosing individual company operations.

[3] Totals may not add because of rounding.

Source: U.S. International Trade Commission, *Synthetic Organic Chemicals: United States Production and Sales, 1973*, ITC Publication 728 (Washington, D.C.: Government Printing Office, 1975).

Table 43

U.S. Production of Selected Agricultural Products, 1950–74

(In thousands of bushels unless otherwise noted)

Product	1950	1960	1970	1971	1972	1973	1974
All wheat	1,019,344	1,354,709	1,351,558	1,617,789	1,544,936	1,705,167	1,793,322
Rye	21,403	33,108	36,840	49,288	29,183	26,263	19,293
Oats	1,369,199	1,153,332	917,159	881,277	691,973	666,867	620,539
Barley	303,772	429,005	416,139	463,601	423,461	421,527	308,077
Corn for grain	2,764,071	3,906,949	4,151,938	5,641,112	5,573,320	5,646,806	4,551,167
Sugar beets [1]	13,535	16,421	26,378	27,096	28,410	24,499	22,268
Rice [2]	38,820	54,591	83,805	85,768	85,439	92,765	114,096
Soybeans for beans	299,249	555,085	1,127,100	1,175,989	1,270,630	1,547,165	1,233,425
Potatoes [2]	259,112	257,104	325,752	319,354	295,955	299,410	340,116
Cotton lint (fiber) [3]	10,014	14,272	10,192	10,477	13,704	12,974	11,702
Tobacco [4]	2,029,557	1,944,175	1,906,453	1,704,884	1,749,085	1,742,105	1,958,214
All hay [1]	103,820	118,158	126,971	129,119	128,614	134,751	126,960

[1] In thousands of tons.

[2] In thousands of hundredweight.

[3] In thousands of bales.

[4] In thousands of pounds.

Source: U.S. Department of Agriculture, *Agricultural Statistics*, annual (Washington, D.C.: Government Printing Office, 1972, 1974); U.S. Department of Agriculture, *Crop Production: 1974 Annual Summary*, CrPr 2-1 (75) (Washington, D.C., 1975).

Table 44

U.S. Yields per Harvested Acre, for Selected Crops, 1950–74

(In bushels per acre unless otherwise noted)

Crop	1950	1960	1970	1971	1972	1973	1974
All wheat	16.5	26.1	31.0	33.9	32.7	31.7	27.4
Rye	12.2	19.6	25.8	28.1	26.9	25.4	21.5
Oats	34.8	43.4	49.2	55.9	51.2	47.4	46.6
Barley	27.2	31.0	42.8	45.7	43.6	40.3	37.2
Corn for grain	38.2	54.7	72.4	88.1	97.1	91.2	71.3
Sugar beets [1]	14.6	17.2	18.7	20.2	21.4	20.1	18.3
Rice [2]	2,371	3,423	4,618	4,718	4,700	4,274	4,441
Soybeans for beans	21.7	23.5	26.7	27.5	27.8	27.7	23.5
Potatoes [3]	152.6	185	229	230	236	230	246
Cotton lint (fiber) [2]	269	446	438	438	507	520	443
Tobacco [2]	1,269	1,703	2,122	2,035	2,076	1,965	2,036
All hay [1]	1.38	1.76	2.06	2.10	2.15	2.17	2.10

[1] In tons per acre.
[2] In pounds per acre.
[3] In hundredweight per acre.

Source: U.S. Department of Agriculture, *Agricultural Statistics*, annual (Washington, D.C.: Government Printing Office, 1972, 1974); U.S. Department of Agriculture, *Crop Production: 1974 Annual Summary*, CrPr 2-1 (75) (Washington, D.C., 1975).

Table 45

U.S Consumption of Commercial Fertilizers, 1950–74[1]

(In tons)

State	Commercial fertilizer						
	1950[2]	1960[2]	1970[2]	1971[2]	1972[2]	1973[2]	1974[2]
Alabama	1,139,773	1,073,733	1,033,032	1,036,274	1,108,966	1,122,674	1,137,697
Alaska	NA	4,319	4,808	4,553	4,343	5,233	3,917
Arizona	61,674	185,606	280,507	286,739	326,654	334,626	371,833
Arkansas	318,640	364,603	572,697	597,543	678,377	633,887	745,035
California	1,036,301	2,768,041	3,137,942	3,185,962	3,412,994	3,510,061	4,214,943
Colorado	39,143	96,260	268,467	290,329	309,551	320,056	362,591
Connecticut	(3)	(4)	57,179	60,036	61,385	69,582	70,470
Delaware	57,507	90,953	115,731	117,029	106,059	128,632	124,791
District of Columbia	1,964	5,413	8,595	8,576	7,792	7,601	5,862
Florida	877,955	1,558,574	1,892,364	1,738,067	1,850,893	1,893,309	1,920,446
Georgia	1,188,036	1,455,253	1,845,703	1,915,769	1,984,885	2,145,174	2,210,560
Hawaii	115,290	127,255	189,262	199,858	202,725	171,199	165,720
Idaho	51,645	149,513	423,208	438,920	421,192	509,121	503,739
Illinois	870,556	1,452,144	3,141,728	3,199,757	2,926,904	3,131,408	3,522,773
Indiana	798,467	1,152,250	1,973,433	2,051,729	1,866,981	2,043,535	2,271,268
Iowa	332,661	690,692	2,647,437	2,651,544	2,605,843	2,665,740	2,939,951
Kansas	160,215	333,961	1,230,916	1,167,989	1,245,272	1,447,795	1,531,724
Kentucky	554,090	569,387	764,036	829,795	808,131	845,059	948,809
Louisiana	274,590	309,548	555,281	615,495	647,296	589,724	731,626
Maine	(3)	(4)	143,924	136,346	124,735	137,147	146,819
Maryland	251,747	299,562	353,586	432,656	336,063	443,445	400,725
Massachusetts	(3)	(4)	69,596	71,123	72,234	76,738	77,373
Michigan	474,485	670,471	863,654	1,027,684	942,565	896,523	1,016,000
Minnesota	217,996	538,450	1,306,881	1,750,988	1,608,873	1,780,511	1,800,339
Mississippi	640,607	693,514	739,649	746,673	893,206	916,202	965,700
Missouri	407,710	802,346	1,488,168	1,491,640	1,578,557	1,417,782	1,621,076
Montana	10,957	44,728	186,451	202,947	203,000	245,929	229,874

Nebraska	43,667	321,934	1,242,810	1,352,103	1,364,811	1,467,673	1,493,859
Nevada	1,124	5,585	16,221	16,998	17,933	24,719	24,945
New Hampshire	(3)	(4)	18,132	19,673	18,885	18,221	21,132
New Jersey	237,750	237,141	209,247	226,279	189,721	217,446	217,127
New Mexico	19,241	46,154	95,820	101,152	93,610	113,367	116,060
New York	608,545	592,295	613,232	640,776	624,551	627,356	649,565
North Carolina	1,740,348	1,602,913	1,785,622	1,825,647	1,706,537	1,845,207	2,052,205
North Dakota	18,671	143,977	355,236	331,703	341,595	483,505	478,351
Ohio	906,634	1,086,748	1,404,412	1,579,057	1,517,094	1,551,576	1,818,209
Oklahoma	141,266	145,343	626,304	631,585	638,595	718,978	771,753
Oregon	96,861	198,693	418,032	444,129	444,873	535,535	453,206
Pennsylvania	632,060	668,247	679,697	705,618	663,537	681,308	716,[illegible]
Rhode Island	(3)	(4)	16,587	16,977	16,922	16,845	27,281
South Carolina	874,528	783,943	855,625	859,677	860,218	982,175	965,043
South Dakota	5,496	36,098	292,439	312,413	304,494	366,182	395,297
Tennessee	506,338	624,039	750,447	745,972	736,135	766,491	816,050
Texas	553,535	708,891	2,251,805	2,320,837	2,514,837	2,556,774	2,913,013
Utah	15,757	42,354	90,422	89,844	109,429	121,400	121,273
Vermont	(3)	(4)	53,742	55,378	53,908	54,418	64,857
Virginia	728,304	749,634	825,873	823,704	802,905	823,251	803,048
Washington	81,382	276,486	541,645	586,108	608,044	781,285	774,673
West Virginia	104,148	75,388	71,122	67,116	72,891	68,475	77,004
Wisconsin	384,032	422,652	846,719	901,861	942,189	987,733	1,040,029
Wyoming	5,828	18,179	72,086	71,160	79,821	89,986	80,905
United States	18,092,922	24,632,732	39,433,512	40,981,788	41,059,011	43,148,599	46,932,599

NA=Not available.

[1] Includes Government distribution and secondary and micronutrient fertilizers, but not liming materials.

[2] Year ended June 30.

[3] Data for individual New England states are not available. Total for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont is 505,398 tons.

[4] Data for individual New England states are not available. Total for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont is 409,462 tons.

Source: U.S. Department of Agriculture, *Commercial Fertilizers: Consumption of Commercial Fertilizers, Primary Plant Nutrients, and Micronutrients*, Statistical Bulletin No. 472 (Washington, D.C.: Government Printing Office, 1971); U.S. Department of Agriculture, *Commercial Fertilizers: Consumption in the United States, Year Ended June 30, 1974*, SpCr 7(5–75) (Washington, D.C., 1975); U.S. Department of Agriculture, *Agricultural Statistics*, annual (Washington, D.C.: Government Printing Office, 1972, 1973, 1974).

Table 46

Energy Use in the U.S. Food System, 1940–70

(In trillions of Btu)

Component	1940	1950	1960	1970
On farm				
Fuel (direct use)	277.8	626.9	746.0	920.6
Electricity	2.8	130.5	182.9	253.2
Fertilizer	49.2	95.2	162.7	373.0
Agricultural steel	6.3	10.7	6.7	7.9
Farm machinery	35.7	119.0	206.3	317.4
Tractors	50.8	122.2	46.8	76.6
Irrigation	71.4	99.2	132.1	138.9
Subtotal	493.6	1,203.9	1,484.0	2,087.6
Processing industry				
Food processing industry	583.3	761.9	888.8	1,222.1
Food processing machinery	2.8	19.8	19.8	23.8
Paper packaging	33.7	67.5	111.1	150.8
Glass containers	55.6	103.2	123.0	186.5
Steel cans and aluminum	150.8	246.0	341.2	484.1
Transport (fuel)	196.8	404.7	608.3	979.7
Trucks and trailers (manufacture)	111.1	196.4	175.4	293.6
Subtotal	1,133.7	1,799.5	2,267.7	3,340.7
Commercial and home				
Commercial refrigeration and cooking	480.1	595.2	738.8	1,043.6
Refrigeration machinery (home and commercial)	39.7	99.2	127.0	242.0
Home refrigeration and cooking	572.2	802.7	1,097.5	1,904.6
Subtotal	1,092.0	1,497.1	1,963.4	3,190.3
Grand total [1]	2,719.3	4,500.5	5,715.1	8,618.4

[1] Totals may not add because of rounding.

Source: U.S. Congress, Senate, Committee on Agriculture and Forestry, *The U.S. Food and Fiber Sector: Energy Use and Outlook*, Committee Print, 93d Cong., 2d sess., prepared by U.S. Department of Agriculture (Washington, D.C.: Government Printing Office, 1974); J. S. Steinhart and C. E. Steinhart, "Energy Use in the U.S. Food System," *Science*, 184 (4134) (April 19, 1974), pp. 307–316.

Table 47

Uses and Sources of Water in the United States, 1955–70

(In billions of gallons per day [1])

Uses and sources	1955	1960	1965	1970
Offchannel water use (withdrawals) [2]				
Public supplies [3]	17	21	24	27
Rural domestic and livestock [4]	3.6	3.6	4.0	4.5
Irrigation	110	110	120	130
Self-supplied industrial [5]				
Thermoelectric power	72	100	130	170
Other self-supplied industrial	39	38	46	47
Total withdrawals	241.6	272.6	324.0	378.5
Water consumed by offchannel uses [6]	NA	61	77	87
Sources of water for offchannel uses				
Fresh ground water	47	50	60	68
Saline ground water [7]	0.65	0.38	0.47	1.0
Fresh surface water	180	190	210	250
Saline surface water [7]	18	31	43	53
Reclaimed sewage [8]	0.2	0.1	0.7	0.5
Water used for hydroelectric power [9]	1,500	2,000	2,300	2,800

NA=Not available.

[1] Totals may not add because of rounding.

[2] Offchannel water use, or withdrawal, is the amount of water withdrawn from its source. It is equivalent to "intake" or "water requirement" as used in industry and agriculture respectively. The term "offchannel uses" is used to represent all withdrawal uses other than hydroelectric power generation.

[3] Water obtained from water utilities that serve the general public. Such water has domestic, commercial, and industrial uses.

[4] Rural domestic and livestock uses are by individual families and small communities not served by a water utility.

[5] Water is self-supplied if a public supply is either not available or not used.

[6] Water consumed by offchannel uses is that part of the water withdrawn that is no longer available because it has been evaporated, transpired, incorporated into products and crops, consumed by man or livestock, or otherwise removed from the water environment.

[7] Water with more than 1,000 milligrams of dissolved solids per liter of solution is classed as "saline" regardless of the nature of the minerals present.

[8] Reclaimed sewage is effluent from a sewage treatment plant that has been diverted before reaching a natural waterway and becoming part of the streamflow.

[9] Hydroelectric power generation is an "inchannel use" of water, because it takes place in the river channel.

Source: C. Richard Murray and E. Bodette Reeves, *Estimated Use of Water in the United States in 1970*, USGS Circular 676 (Washington, D.C.: Government Printing Office, 1972).

Table 48

Volume and Cost of Dredging Work Done by the U.S. Army Corps of Engineers, Actual 1970–74 and Estimated 1975

Item and division[1]	1970	1971	1972	1973	1974	1975[2]
Volume, in thousands of cubic yards						
New England	3,046	5,513	2,528	1,209	404	874
North Atlantic	26,215	35,653	36,287	31,146	17,025	24,856
South Atlantic	76,080	60,979	57,742	51,402	40,409	67,095
Ohio River	4,139	4,405	5,435	5,035	8,583	6,457
North Central	18,024	11,825	11,980	11,885	12,475	12,589
Missouri River	1,245	2,479	2,376	1,595	3,376	3,025
Lower Mississippi Valley	138,506	134,788	109,443	148,468	191,285	167,030
South Pacific	10,402	10,025	10,779	8,070	13,111	8,485
Southwestern	94,915	69,370	61,393	37,121	82,052	47,394
North Pacific	19,614	22,981	17,687	16,706	18,131	21,213
Total	392,185	357,658	315,650	312,646	386,850	[illegible]

Cost, in thousands of dollars [3]						
New England	5,919	10,275	5,581	4,198	811	7,030
North Atlantic	20,111	28,056	32,132	34,796	25,179	41,267
South Atlantic	25,131	28,415	31,284	33,347	38,889	59,980
Ohio River	1,195	1,721	2,785	2,368	4,385	8,437
North Central	15,627	12,400	13,017	16,890	12,725	16,125
Missouri River	774	1,358	1,606	1,464	2,160	1,944
Lower Mississippi Valley	22,698	22,683	19,063	26,045	46,333	49,001
South Pacific	5,598	4,449	6,144	5,747	8,789	10,087
Southwestern	22,663	21,330	18,399	18,862	26,067	24,905
North Pacific	8,631	9,844	10,386	13,014	9,553	13,486
Total	128,347	140,532	140,396	156,830	174,891	232,262

[1] As defined by the Corps of Engineers.

[2] Estimated.

[3] Cost to Corps of dredging contracts.

Source: U.S. Department of the Army, Corps of Engineers, "Volume of Dredging Work" and "Value of Dredging Work" (undated mimeos).

Table 49

Estimated Flood Damages Incurred and Prevented, 1960–74 [1]

(In thousands of dollars)

Region	1960 [2]	1970 [3]	1971 [3]	1972 [3]	1973 [3]	1974 [3]
Damages incurred [4]						
New England	7,250	0	0	60	67,900	10,175
Middle Atlantic	6,025	918	167,918	3,997,580	56,114	68,587
South Atlantic–Gulf	13,952	17,308	8,989	73,050	43,413	93,441
Great Lakes	1,942	3,100	1,000	123,848	1,920	7,805
Ohio	7,519	10,158	12,263	119,636	89,520	46,310
Tennessee	0	0	0	0	NR	NR
Upper Mississippi	12,901	8,996	0	0	277,650	114,229
Lower Mississippi	496	14,831	7,737	4,045	476,882	16,809
Souris–Red–Rainy	0	13,021	1,008	0	NR	NR
Missouri	28,105	22,911	7,862	84,131	147,267	139,915
Arkansas–White–Red	3,705	6,036	26,747	7,943	21,831	57,922
Texas Gulf	8,205	4,149	26,383	49,749	105,182	11,806
Rio Grande	0	0	145	0	647	575
Upper Colorado	0	15	555	0	NR	NR
Lower Colorado	0	5,000	3,476	0	NR	NR
Great Basin	0	356	1,860	0	NR	NR
Columbia–North Pacific	360	2,927	8,680	26,746	2,251	88,534
California–South Pacific	516	47,727	3,522	3,500	19,557	45,868
Alaska	0	0	8,630	5,800	140	1,500
Hawaii	0	0	500	0	NR	NR
Total	92,976	157,453	287,275	4,496,088	1,310,474	703,476

Damages prevented [3]						
New England	40,100	1,216	676	9,120	7,171	54,990
Middle Atlantic	25,700	5,823	3,055	496,056	22,841	7,580
South Atlantic–Gulf	7,700	37,167	33,520	34,270	20,076	74,537
Great Lakes	4,200	3,179	4,668	152,583	8,094	6,440
Ohio	46,500	196,854	33,756	1,137,784	109,964	164,059
Tennessee	0	612	604	5	NR	NR
Upper Mississippi	11,500	29,011	5,965	3,446	1,078,109	56,797
Lower Mississippi	30,200	267,760	161,748	73,496	9,046,518	4,307,720
Souris–Red–Rainy	0	551	1,229	2,142	NR	NR
Missouri	249,300	38,135	29,672	107,996	170,512	1,091,392
Arkansas–White–Red	32,300	34,162	10,974	20,526	102,610	227,935
Texas Gulf	37,000	22,020	15,402	28,156	29,879	51,874
R[illegible] Grande	0	866	1,111	2,395	5,177	351
[illegible]r Colorado	0	0	0	0	NR	NR
[illegible] Colorado	0	0	200	1,750	NR	NR
Great Basin	0	0	0	95	NR	NR
Columbia–North Pacific	5,700	40,073	81,052	181,290	14,949	345,347
California–South Pacific	4,900	124,760	7,768	21,700	150,645	105,[illegible]03
Alaska	200	21	200	50	12	0
Hawaii	0	364	111	0	NR	NR
Total	495,300	802,574	391,711	2,272,860	10,766,557	6,494,925

NR—Not reported.

[1] As defined by the Water Resources Council.

[2] Data for 1960, 1970, and 1971 are for calendar years; 1972, 1973, and 1974 are fiscal years.

[3] As estimated by the Corps of Engineers.

Source: U.S. Department of the Army, Corps of Engineers, "Preliminary Flood Information Summary," mimeograph DAEN–CWE–Y, February 20, 1975; U.S. Department of the Army, Corps of Engineers, "Floods and Flood Damages Prevented," mimeograph DAEN–CWE–Y, May 8, 1975.

Table 50

National Wildlife Refuge System Lands, by State and Category, 1974

(In acres)

State	Total national wildlife refuge system [1]	Migratory bird refuges (waterfowl)	Waterfowl production areas	Migratory bird refuges (general)	Game ranges	Big game refuges	Wildlife ranges	Coordination areas [2]
Alabama	46,332	46,332	—	—	—	—	—	—
Alaska	23,819,332	6,800	—	3,288,447	—	6,901,633	12,102,452	—
Arizona	66,658	59,762	—	—	1,520,000	—	—	6,896
Arkansas	122,934	122,934	—	—	—	—	—	—
California	194,767	192,735	—	211	—	—	—	1,821
Colorado	50,076	48,923	—	—	—	—	—	1,153
Connecticut	178	178	—	—	—	—	—	—
Delaware	22,645	22,065	—	—	—	—	—	580
District of Columbia	—	—	—	—	—	—	—	—
Florida	437,383	415,869	—	16,872	—	4,642	—	—
Georgia	440,920	66,960	—	373,960	—	—	—	—
Hawaii	3,039	—	—	3,039	—	—	—	—
Idaho	71,959	66,169	—	—	—	—	—	5,790
Illinois	116,075	87,934	—	—	—	—	—	28,141
Indiana	7,724	7,724	—	—	—	—	—	—
Iowa	73,248	66,667	—	—	—	—	—	6,581
Kansas	51,062	51,061	—	—	—	—	—	—
Kentucky	2,040	2,040	—	—	—	—	—	—
Louisiana	237,785	228,730	—	9,055	—	—	—	—
Maine	25,408	24,340	1,068	—	—	—	—	—
Maryland	18,759	18,759	—	—	—	—	—	—
Massachusetts	11,369	10,749	—	620	—	—	—	—
Michigan	104,853	104,343	—	510	—	—	—	—

Minnesota	387,229	174,788	130,630	1	—	—	—	81,810
Mississippi	58,316	58,316	—	—	—	—	—	—
Missouri	55,039	42,964	—	—	—	—	—	12,075
Montana	1,043,259	171,924	16,724	468,533	360,845	18,540	—	6,693
Nebraska	156,293	122,285	14,597	—	—	18,667	—	743
Nevada	2,339,794	61,003	—	248	512,956	57,465	1,588,459	119,663
New Hampshire	738	—	—	738	—	—	—	—
New Jersey	31,244	30,352	—	—	—	—	—	892
New Mexico	374,836	95,384	—	—	—	278,991	—	461
New York	20,912	20,880	—	10	—	—	—	22
North Carolina	110,093	110,093	—	—	—	—	—	—
North Dakota	1,176,020	273,893	889,478	27	—	1,674	—	10,948
Ohio	7,955	7,873	—	82	—	—	—	—
Oklahoma	136,377	77,357	—	—	—	59,020	—	—
Oregon	492,493	241,931	—	523	—	242,869	—	7,170
Pennsylvania	8,227	7,994	—	233	—	—	—	—
Rhode Island	127	127	—	—	—	—	—	—
South Carolina	208,118	161,781	—	—	—	—	—	46,337
South Dakota	360,659	42,390	318,269	—	—	—	—	—
Tennessee	81,376	81,376	—	—	—	—	—	—
Texas	198,614	194,942	—	3,672	—	—	—	—
Utah	100,975	94,250	—	—	—	—	—	6,725
Vermont	4,794	4,794	—	—	—	—	—	—
Virginia	73,919	19,057	—	54,862	—	—	—	—
Washington	173,118	83,897	—	31,435	—	40,264	—	17,522
West Virginia	—	—	—	—	—	—	—	—
Wisconsin	207,375	149,277	—	29	—	—	—	58,069
Wyoming	72,956	32,804	—	—	—	23,861	—	16,291
United States	33,805,389	4,012,798	1,370,766	4,253,107	2,393,801	7,647,624	13,690,910	436,383

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[1] Totals may not add because of rounding.

[2] Areas of acquired land or public land withdrawn by the U.S. Fish and Wildlife Service and made available to the various states or instrumentalities thereof by cooperative agreement for management of wildlife resources in accordance with the Act of March 10, 1934, 48 Stat. 401, as amended.

Source: U.S. Department of the Interior, Division of Realty, "Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service as of June 30, 1974" (undated mimeo).

Table 51

Fishing and Hunting Summary, 1955–70

(In thousands)

	1955	1960	1965	1970
Number of fishermen and hunters	24,917	30,435	32,881	36,277
Number of fishermen	20,813	25,323	28,348	33,158
Freshwater	18,420	21,677	23,962	29,363
Saltwater	4,557	6,292	8,305	9,460
Number of hunters	11,784	14,637	13,583	14,336
Small-game	9,822	12,105	10,576	11,671
Big-game	4,414	6,277	6,566	7,774
Waterfowl [1]	1,986	1,955	1,650	2,894
Expenditures of fishermen and hunters [2]	$2,850,979	$3,852,116	$4,046,440	$7,101,531
Expenditures of fishermen	1,914,292	2,690,872	2,925,304	4,958,883
Freshwater	1,425,353	2,064,680	2,125,652	3,734,178
Saltwater	488,939	626,191	799,656	1,224,705
Expenditures of hunters	936,687	1,161,242	1,121,135	2,142,648
Small-game	494,033	726,118	615,234	945,634
Big-game	323,909	345,694	418,764	952,563
Waterfowl	118,745	89,431	87,136	244,431
Number of recreation days spent fishing and hunting	566,870	658,308	708,578	909,876
Fishing	397,447	465,769	522,759	706,187
Freshwater	338,826	385,167	426,922	592,494
Saltwater	58,621	80,602	95,837	113,694
Hunting	169,423	192,539	185,819	203,689
Small-game	118,630	138,192	128,448	124,041
Big-game	30,834	39,190	43,845	54,536
Waterfowl	19,959	15,158	13,526	25,113

See footnotes at end of table.

Table 51—Continued

Fishing and Hunting Summary, 1955–70

	1955	1960	1965	1970
Passenger-miles traveled by automobile for fishing and hunting	23,982,730	26,447,562	30,447,130	37,829,515
Fishing	17,910,434	18,834,947	22,111,249	28,722,782
Freshwater	15,006,433	15,430,001	17,972,943	23,263,506
Saltwater	2,904,001	3,404,945	4,138,307	5,459,276
Hunting	6,072,296	7,612,615	8,365,881	9,106,734
Small-game	3,094,974	3,962,020	4,010,499	3,958,723
Big-game	2,222,373	2,998,178	3,718,767	3,934,818
Waterfowl	754,949	652,417	636,615	1,213,193

[1] The number of waterfowl hunters in the 1970 survey is not comparable with those reported in the 1960 and 1965 surveys. In 1960 and 1965, respondent sportsmen were not included in the waterfowl hunter total if they reported that they went waterfowl hunting but did not take the trip *chiefly* to hunt waterfowl. In 1970, all respondents who reported that they had hunted waterfowl during 1970, whether or not the trip's purpose was *chiefly* to hunt waterfowl, were included in the total. The number of hunters who did not take trips chiefly to hunt waterfowl in 1970 was 1,054,000.

[2] Excludes expenditures on alcoholic beverages.

Source: U.S. Department of the Interior, Fish and Wildlife Service, ***National Survey of Fishing and Hunting:*** 1970, Resource Publication 95 (Washington, D.C.: Government Printing Office, 1972).

Table 52

Summary of Recreation-Related Industries, Establishments with Payrolls, 1958–72

(In thousands of dollars)

Item	1958	1963	1967	1972
Number of establishments				
Retail trade				
Boat dealers	NA	2,670	3,208	4,318
Sporting goods stores	5,410	6,316	7,293	[1]12,356
Bicycle shops	846	999	1,056	
Service industries				
Motels, tourist courts	NA	23,159	22,697	27,739
Sporting, recreational camps	3,923	4,899	4,682	3,165
Sport clubs, promoters	486	445	455	537
Manufacturing				
Boat building and repairing	1,651	1,626	1,596	1,778
Motorcycles, bicycles, and parts	51	88	91	222
Sporting and athletic goods	1,210	1,419	1,366	1,554
Travel trailers and campers	NA	NA	NA	1,033
Volume of business [2]				
Retail Trade				
Boat dealers	NA	406,855	751,079	1,560,308
Sporting goods stores	491,826	608,607	925,896	[1]2,283,851
Bicycle shops	37,891	56,474	82,636	
Service Industries				
Motels, tourist courts	NA	1,062,962	1,556,975	3,854,471
Sporting, recreational camps	124,376	176,594	203,913	224,537
Sports clubs, promoters	118,554	158,804	226,067	512,904
Manufacturing				
Boat building and repairing	329,009	360,208	571,400	1,053,600
Motorcycles, bicycles, and parts	121,527	192,851	299,600	659,500
Sporting and athletic goods	377,815	704,718	853,300	1,736,600
Travel trailers and campers	NA	NA	NA	1,347,100

See footnotes at end of table.

Table 52—Continued

Summary of Recreation-Related Industries, Establishments with Payrolls, 1958–72

Item	1958	1963	1967	1972
Paid Employees				
Retail trade				
Boat dealers	NA	9,360	13,111	23,617
Sporting goods stores	18,435	20,578	25,351	[1]51,284
Bicycle shops	1,902	2,206	2,158	
Service industries				
Motels, tourist courts	NA	96,374	128,755	273,056
Sporting, recreational camps	17,617	7,488	7,482	10,524
Sports clubs, promoters	7,800	8,663	10,321	14,515
Manufacturing				
Boat building and repairing	25,295	24,861	30,500	40,900
Motorcycles, bicycles, and parts	7,578	9,662	12,000	17,600
Sporting and athletic goods	37,164	40,543	45,200	61,300
Travel trailers and campers	NA	NA	NA	37,300

NA = Not available.

[1] In 1972, sporting goods stores and bicycle shops were combined to form one category.

[2] Sales for retail trade, receipts for service industries, and value of shipments for manufacturing.

Source: U.S. Bureau of the Census, *1972 Census of Manufacturers*, MC72(2)–39B and MC72(2)–37C (Washington, D.C.: Government Printing Office, 1974).

Table 53

U.S. Gross Consumption of Energy Resources, by Major Source and Consuming Sector, 1970–74

(In trillions of Btu)

Source and consuming sector	1970	1971	1972	1973	1974 [1]
U.S. total energy inputs					
Anthracite	210	186	150	144	132
Bituminous coal and lignite	12,488	11,857	12,273	13,150	13,037
Natural gas (dry) [2]	22,029	22,819	23,035	22,712	22,237
Petroleum [3]	29,537	30,570	32,966	34,851	33,490
Hydropower [4]	2,650	2,862	2,946	2,998	3,052
Nuclear power [4]	229	404	576	888	1,173
Total gross energy inputs [5]	67,143	68,698	71,946	74,743	73,121
Household and commercial					
Anthracite	103	98	75	74	62
Bituminous coal and lignite	324	308	233	222	229
Natural gas (dry) [2]	7,108	7,366	7,642	7,318	7,116
Petroleum [3]	6,453	6,440	6,667	6,689	6,390
Hydropower [4]	XX	XX	XX	XX	XX
Nuclear power [4]	XX	XX	XX	XX	XX
Total gross energy inputs [5]	13,988	14,212	14,588	14,303	13,797
Utility electricity distributed [6]	3,000	3,209	3,478	3,709	3,687
Total sector energy inputs [7]	16,988	17,421	18,066	18,012	17,484
Industrial					
Anthracite	59	47	35	33	32
Bituminous coal and lignite	4,943	4,256	4,232	4,344	4,176
Natural gas (dry) [2]	10,161	10,570	10,591	10,970	11,129
Petroleum [3]	5,061	5,094	5,668	6,059	5,826
Hydropower [4]	34	34	35	34	34
Nuclear power [4]	XX	XX	XX	XX	XX
Total gross energy inputs [5]	20,258	20,001	20,271	21,440	21,197
Utility electricity distributed [6]	2,210	2,293	2,493	2,634	2,665
Total sector energy inputs [7]	22,468	22,294	23,020	24,074	23,862
Transportation [8]					
Anthracite	NA	NA	NA	NA	NA
Bituminous coal and lignite	8	6	4	3	2
Natural gas (dry) [2]	745	766	787	743	664
Petroleum [3]	15,720	16,286	17,264	18,164	17,608
Hydropower [4]	XX	XX	XX	XX	XX
Nuclear power [4]	XX	XX	XX	XX	XX
Total gross energy inputs [5]	16,473	17,058	18,053	18,910	18,274
Utility electricity distributed [6]	16	17	17	15	16
Total sector energy inputs [7]	16,489	17,075	18,072	18,925	18,290
Electricity generation utilities					
Anthracite	48	42	40	37	38
Bituminous coal and lignite	7,213	7,288	7,796	8,581	8,630
Natural gas (dry) [2]	4,015	4,117	4,086	3,681	3,328
Petroleum [3]	2,087	2,543	3,134	3,656	3,448
Hydropower [4]	2,616	2,828	2,911	2,964	3,018
Nuclear power [4]	229	404	576	888	1,173
Total gross energy inputs [5]	16,208	17,222	18,543	19,807	19,635
Utility electricity distributed [6]	5,226	5,519	5,988	6,358	6,368
Total sector energy inputs [7]	XX	XX	XX	XX	XX

See footnotes at end of table.

Table 53—Continued

Major Source and Consumer Sector, 1970–74

Source and consuming sector	1970	1971	1972	1973	1974[1]
Miscellaneous and unaccounted for					
Anthracite	0	0	0	0	0
Bituminous coal and lignite	0	0	0	0	0
Natural gas (dry)[2]	0	0	0	0	0
Petroleum[3]	216	207	233	283	218
Hydropower[4]	0	0	0	0	0
Nuclear power[4]	0	0	0	0	0
Total gross energy inputs[5]	216	207	233	283	218
Utility electricity distributed[6]	0	0	0	0	0
Total sector energy inputs[7]	216	207	233	283	218

Totals may not add because of rounding.

NA=Not available.

XX=Not applicable.

[1] Preliminary.

[2] Excludes natural gas liquids.

[3] Petroleum products including still gas, liquefied refining gas (LRG), and natural gas liquids.

[4] Represents outputs of hydropower (adjusted for net imports or net exports) and nuclear power converted to theoretical energy inputs calculated from national average heat rates for fossil-fueled steam-electric plants, using a value of 10,494 Btu per net kilowatt-hour generated in 1970. Energy inputs for hydropower in 1971 and 1972 are converted at an average heat rate of 10,478 Btu per net kilowatt-hour generated. Energy inputs for nuclear power in 1971, 1972, 1973 and 1974 are converted at an average heat rate 10,660 Btu per net kilowatt-hour based on information from the Atomic Energy Commission. Excludes inputs for power generated by nonutility fuel-burning plants that are included within the other consuming sectors.

[5] Gross energy is that contained in all types of commercial energy at the time it is incorporated in the economy, whether energy is produced domestically or imported. Gross energy comprises inputs of primary fuels (or their derivatives) and outputs of hydropower and nuclear power converted to theoretical energy inputs. Gross energy includes energy used for production, processing, and transportation of energy proper.

[6] Utility electricity, generated and imported, distributed to the other consuming sectors as energy resource inputs. Distribution to sectors is based on historical series in the Edison Electric Institute Yearbook. Conversion of electricity to energy equivalent by sectors was made at the value of contained energy corresponding to 100% efficiency using a theoretical rate of 3,412 Btu per kilowatt-hour.

[7] Energy resource inputs by sector, including direct fuels and electricity distributed.

[8] Includes bunkers and military transportation.

Source: U.S. Department of the Interior, Bureau of Mines, *Minerals Yearbook* annual, Vol. I (Washington, D.C.: Government Printing Office, 1970, 1973, and 1974); U.S. Department of the Interior, Bureau of Mines, unpublished data.

Table 54

U.S. Imports and Exports of Fossil Fuels, 1950–74

Fuel	1950		1960		1970		1974[1]	
	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Coal[2]	365	29,360	262	37,981	36	72,411	2,000	61,100
Petroleum[3]	311	112	665	74	1,248	95	2,236	81
Gas								
Natural gas[4]	0	25,727	155,646	11,332	820,780	69,813	940,000	80,000
Natural gas liquids	NA	NA	[5] 1,631	[5,6] 2,990	[5] 18,921	[5,6] 9,955	([7])—	([7])—

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[1] Preliminary.

[2] In thousands of short tons of anthracite, bituminous coal, and lignite. Exports for 1950, 1960, and 1970 include shipments to U.S. Armed Forces in West Germany.

[3] In millions of barrels, includes crude oil and products. Natural gas liquids included in 1974 under petroleum.

[4] In millions of cubic feet.

[5] In thousands of 42-gallon barrels.

[6] Natural gasoline included with exports of petroleum.

[7] Included with petroleum.

Source: American Petroleum Institute, Annual Statistical Review, *U.S. Petroleum Industry Statistics 1956–71*, annual (Washington, D.C., 1972); Walter G. Dupree, Jr., and James A. West, *U.S. Energy Through the Year 2000* (Washington, D.C.: Government Printing Office, 1973); Department of the Interior, "U.S. Energy Use Down after Two Decades of Increases," press release, April 1975.

Table 55

Estimated Motor Vehicle Miles Traveled in the United States, 1960–73

(In millions)

Travel item	Main rural roads			Local rural roads			Urban streets			Total travel		
	1960	1970	1973	1960	1970	1973	1960	1970	1973	1960	1970	1973
Total U.S. motor vehicle travel	288,483	412,593	462,979	98,777	130,739	138,196	331,585	577,373	707,387	718,845	1,120,705	1,308,562
Personal passenger vehicles												
Passenger cars[1]	225,755	NA	NA	77,528	NA	NA	284,800	NA	NA	588,083	890,844	1,016,861
Motorcycles	(2)	NA	NA	(2)	NA	NA	(2)	NA	NA	(2)	10,148	19,594
All personal passenger vehicles	NA	307,047	341,633	NA	99,402	102,631	NA	494,543	592,191	NA	900,992	1,036,455
Buses												
Commercial	869	939	890	154	194	113	1,849	1,810	1,545	2,872	2,943	2,548
School	597	784	920	635	902	995	249	414	497	1,481	2,100	2,412
All buses	1,466	1,723	1,810	789	1,096	1,108	2,098	2,224	2,042	4,353	5,043	4,960
Cargo vehicles												
Single unit trucks	(3)	76,949	86,764	(3)	28,671	33,292	(3)	68,823	99,072	(3)	174,443	219,128
Combinations	(3)	26,874	32,772	(3)	1,570	1,165	(3)	11,783	14,082	(3)	40,227	48,019
All trucks	61,262	103,823	119,536	20,460	30,241	34,457	44,687	80,606	113,154	126,409	214,670	267,147

NA = Not available.

[1] Separate estimates of passenger car and motorcycle travel are not available by highway category; Includes taxicabs and motorcycles (575,497 registered).

[2] Motorcycles included with passenger cars.

[3] Included in "all trucks" category.

Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*, annual (Washington, D.C.: Government Printing Office 1971 and 1975).

Table 56

Passenger Cars in Use, by Age of Vehicle, 1963–74

(In thousands)

Age in years[1]	1963[2]		1968[2,3]		1972[2,3]		1973[2,3]		1974[2,3]	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Less than 1	5,251	8.3	6,182	8.2	7,169	8.3	7,988	8.9	6,433	6.9
1–2	6,614	10.5	8,122	10.8	8,915	10.3	10,158	11.3	11,269	12.2
2–3	5,505	8.7	8,836	11.7	8,851	10.2	8,715	9.7	10,147	11.0
3–4	6,197	9.8	8,939	11.9	9,122	10.6	8,612	9.6	8,622	9.3
4–5	5,730	9.1	7,667	10.2	8,596	9.9	8,881	9.9	8,493	9.2
5–6	4,171	6.6	7,058	9.4	7,499	8.7	8,291	9.2	8,615	9.3
6–7	5,593	8.8	6,183	8.2	7,930	9.2	7,120	7.9	7,931	8.6
7–8	5,262	8.3	4,657	6.2	7,583	8.8	7,333	8.2	6,624	7.2
8–9	5,489	8.7	4,615	6.1	5,920	6.8	6,715	7.5	6,531	7.1
9–10	3,206	5.1	3,347	4.4	4,713	5.5	4,963	5.5	5,710	6.2
10–11	3,201	5.1	1,709	2.3	3,343	3.9	3,698	4.1	3,976	4.3
11–12	1,564	2.5	1,990	2.6	1,824	2.1	2,470	2.8	2,824	3.0
12–13	1,713	2.7	1,612	2.1	1,413	1.6	1,268	1.4	1,813	2.0
13–14	1,654	2.6	1,496	2.0	805	0.9	967	1.1	901	1.0
14–15	864	1.3	743	1.0	389	0.5	548	0.6	682	0.7
15–16	414	0.6	623	0.8	526	0.6	274	0.3	391	0.4
16 and older	863	1.3	1,517	2.1	1,813	2.1	1,780	2.0	1,621	1.8
Year not given	93	—	63	—	27	—	23	—	25	—
Total	63,384	100.0	75,358	100.0	86,439	100.0	89,805	100.0	92,608	100.0

[1] Each class interval includes lower but not higher age.

[2] Data as of July 1 of each year.

[3] Beginning in 1966, certain vehicles previously counted as passenger cars have been counted as trucks. The change involved an estimated 700,000 vehicles.

Source: R.L. Polk & Co.

Table 57

U.S. Mass Transit Passengers, 1940–73[1]

(In millions)

Item	1940	1950	1960	1970	1971	1972	1973	1974[2]
Total rail	8,325	6,168	2,313	2,116	2,000	1,942	1,921	1,927
Light rail[3]	5,943	3,904	463	235	222	211	207	197
Heavy rail[4]	2,382	2,264	1,850	1,881	1,778	1,731	1,714	1,730
Trolley coach	534	1,658	657	182	148	130	97	77
Motor bus	4,239	9,420	6,425	5,034	4,699	4,495	4,642	4,998
Total	13,098	17,246	9,395	7,332	6,847	6,567	6,660	7,002

[1] Combined total of all single-vehicle transit rides by (1) initial board (first-ride) revenue passengers, (2) transfer passengers on second and successive rides, and (3) nonrevenue passengers entitled to transportation without charge.

[2] Preliminary.

[3] Streetcar-type transit vehicle railway constructed on private right of way or operating in mixed traffic on shared right of way; formerly known as "subway-surface" or "streetcar" ("trolley car") depending on local usage or preference.

[4] Subway-type transit vehicle railway constructed on exclusive private right of way with high-level platform stations; formerly known as "subway" or "elevated (railway)."

Source: American Public Transit Association, '74–'75 *Transit Fact Book* (Washington, D.C., undated).

Table 58

U.S. Population, by State, 1920–74 [1]

(In thousands)

State	1920	1930	1940	1950	1960	1970	1971	1972	1973	1974
Alabama	2,348	2,646	2,833	3,062	3,274	3,451	3,482	3,521	3,546	3,577
Alaska	55	59	73	129	229	304	315	325	330	337
Arizona	334	436	499	750	1,321	1,792	1,868	1,963	2,073	2,153
Arkansas	1,752	1,854	1,949	1,910	1,789	1,932	1,965	2,008	2,035	2,062
California	3,427	5,677	6,907	10,586	15,870	20,007	20,238	20,411	20,652	20,907
Colorado	940	1,036	1,123	1,325	1,769	2,223	2,281	2,364	2,468	2,496
Connecticut	1,381	1,607	1,709	2,007	2,544	3,041	3,077	3,080	3,080	3,088
Delaware	223	238	267	318	449	551	560	571	573	573
District of Columbia	438	487	663	802	765	756	758	752	734	723
Florida	968	1,468	1,897	2,771	5,004	6,848	7,051	7,347	7,745	8,090
Georgia	2,896	2,909	3,124	3,445	3,956	4,607	4,677	4,733	4,818	4,882
Hawaii	256	368	423	500	642	774	796	816	841	847
Idaho	432	445	525	589	671	718	736	755	776	799
Illinois	6,485	7,631	7,897	8,712	10,086	11,128	11,191	11,244	11,176	11,131
Indiana	2,930	3,239	3,428	3,934	4,674	5,202	5,242	5,286	5,304	5,330
Iowa	2,404	2,471	2,538	2,621	2,756	2,832	2,859	2,884	2,863	2,855
Kansas	1,769	1,881	1,801	1,905	2,183	2,249	2,259	2,268	2,264	2,270
Kentucky	2,417	2,615	2,846	2,945	3,041	3,231	3,278	3,306	3,328	3,357
Louisiana	1,799	2,102	2,364	2,684	3,260	3,652	3,696	3,738	3,746	3,764
Maine	768	797	847	914	975	997	1,010	1,026	1,039	1,047
Maryland	1,450	1,632	1,821	2,343	3,113	3,938	4,001	4,048	4,074	4,094
Massachusetts	3,852	4,250	4,317	4,691	5,160	5,706	5,768	5,796	5,799	5,800
Michigan	3,668	4,842	5,256	6,372	7,834	8,890	8,961	9,013	9,061	9,098
Minnesota	2,387	2,564	2,792	2,982	3,425	3,815	3,854	3,877	3,890	3,917

Mississippi	1,791	2,010	2,184	2,179	2,182	2,220	2,241	2,256	2,317	2,324
Missouri	3,404	3,629	3,785	3,955	4,326	4,688	4,734	4,747	4,768	4,777
Montana	549	538	559	591	679	698	710	716	730	735
Nebraska	1,296	1,378	1,316	1,326	1,417	1,488	1,508	1,528	1,533	1,543
Nevada	77	91	110	160	291	493	511	533	551	573
New Hampshire	443	465	492	533	609	742	758	774	794	808
New Jersey	3,156	4,041	4,160	4,835	6,103	7,193	7,296	7,349	7,325	7,330
New Mexico	360	423	532	681	954	1,023	1,053	1,076	1,099	1,122
New York	10,385	12,588	13,479	14,830	16,838	18,268	18,384	18,367	18,214	18,111
North Carolina	2,559	3,170	3,572	4,062	4,573	5,098	5,158	5,221	5,302	5,363
North Dakota	647	681	642	620	634	620	629	634	635	637
Ohio	5,759	6,647	6,908	7,947	9,734	10,664	10,724	10,722	10,743	10,737
Oklahoma	2,028	2,396	2,336	2,233	2,336	2,567	2,600	2,633	2,669	2,709
Oregon	783	954	1,090	1,521	1,772	2,101	2,135	2,185	2,219	2,266
Pennsylvania	8,720	9,631	9,900	10,498	11,329	11,813	11,888	11,905	11,862	11,835
Rhode Island	604	687	713	792	855	951	958	969	967	937
South Carolina	1,684	1,739	1,900	2,117	2,392	2,597	2,639	2,688	2,724	2,784
South Dakota	637	693	643	653	683	668	675	680	682	682
Tennessee	2,338	2,617	2,916	3,292	3,575	3,937	3,988	4,072	4,095	4,129
Texas	4,663	5,825	6,415	7,711	9,624	11,236	11,416	11,604	11,828	12,050
Utah	449	508	550	689	900	1,066	1,094	1,127	1,150	1,173
Vermont	352	360	359	378	389	446	453	460	466	470
Virginia	2,309	2,422	2,678	3,319	3,986	4,659	4,715	4,765	4,844	4,908
Washington	1,357	1,563	1,736	2,379	2,855	3,413	3,435	3,418	3,431	3,476
West Virginia	1,464	1,729	1,902	2,006	1,853	1,751	1,776	1,795	1,788	1,791
Wisconsin	2,632	2,939	3,138	3,435	3,962	4,429	4,471	4,526	4,539	4,566
Wyoming	194	226	251	291	331	334	340	346	353	359
United States	106,022	123,203	132,165	151,326	179,975	203,810	206,212	208,230	209,844	211,390

[1] Population estimates are as of census date January 1, 1920, April 1 for 1930 to 1950, and July 1 thereafter.

Source: U.S. Bureau of the Census, *Current Population Reports*, Series P-25, Nos. 304, 460, and 539 (Washington, D.C.: Government Printing Office, 1965, 1971, and 1975); U.S. Bureau of the Census, *U.S. Census of Population: 1970*, Vol. 1, Part A (Washington, D.C.: Government Printing Office, 1972).

Table 59

Federal Budgetary Authorities and Outlays for Pollution Control and Abatement, 1970–76

(In millions of dollars)

Activity or agency	Actual										Estimates			
	1970		1971		1972		1973		1974		1975		1976	
	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays
Activity														
Financial aid to state and local governments	874	288	1,082	554	2,112	490	[1] 7,242	[1] 908	5,645	1,867	3,719	2,699	[2] 226	2,752
Research and development [3]	344	296	442	366	487	403	599	489	506	415	713	581	710	684
Standard setting and enforcement [4]	80	72	136	92	172	164	217	215	313	304	372	368	434	417
Manpower development	16	12	19	17	14	10	16	14	12	10	11	10	17	13
Reduce pollution from federal facilities	72	32	116	74	252	152	311	174	337	301	344	469	415	571
Other	48	52	49	45	159	95	135	125	83	79	87	85	130	106
Total [5]	1,432	751	1,823	1,149	3,196	1,314	8,521	1,925	6,895	2,974	5,245	4,213	1,933	4,542
Agency														
Environmental Protection Agency	[6] 1,046	[6] 388	[6] 1,303	[6] 718	2,448	763	7,427	1,113	5,963	2,032	4,246	2,937	[2] 743	3,080
Defense—Military	89	39	134	82	208	134	291	143	308	231	326	309	421	391
Energy Research and Development Administration [7]	120	116	124	122	144	138	186	174	131	104	188	151	236	185
Transportation	17	11	52	22	86	40	90	51	92	59	88	79	97	99
Agriculture	60	91	71	67	100	77	[8] 142	[8] 121	125	123	105	172	119	166
Defense—Civil	3	3	8	7	9	8	13	13	9	9	10	10	10	10
Interior	36	37	46	45	112	73	114	97	48	41	56	51	66	58

Commerce	19	22	25	20	18	12	[8] 150	[8] 102	67	58	50	53	46	49
General Services Administration	1	—	4	2	—	—	—	—	—	—	—	—	—	—
National Aeronautics and Space Administration	21	15	25	25	27	16	61	34	68	23	65	55	65	66
National Science Foundation	7	7	10	9	15	15	15	14	13	14	17	15	13	15
Housing and Urban Development	—	—	—	—	—	—	—	—	8	[9] 155	10	158	10	148
Tennessee Valley Authority	—	—	—	—	—	—	—	—	3	[10] 62	3	142	3	171
Nuclear Regulatory Commission	—	—	—	—	—	—	—	—	54	54	69	69	92	92
Other agencies	12	23	22	31	29	38	32	63	6	9	13	13	13	14
Total [5]	1,432	751	1,823	1,149	3,196	1,314	8,521	1,925	6,895	2,974	5,245	4,213	1,933	4,542

[1] Figures include water and sewer programs of the type funded by FHA and OEO. These figures were not included in previous figures for this activity.

[2] Contract authority for the Environmental Protection Agency's 1976 sewage facility grant program is included as 1975 budget authority since it is allocated and available for obligation in 1975. It therefore appears in columns for budget authority for that year instead of the 1976 column.

[3] In 1970 "Research and Development" also included "Demonstration."

[4] Prior to Fiscal Year 1974, this activity was termed "Federal Abatement and Control Operations."

[5] Data may not sum to totals shown because of independent rounding.

[6] Funding shown for EPA has been adjusted to include activities actually conducted by Departments of Health, Education, and Welfare, Agriculture, and Interior, the Atomic Energy Commission, and the Federal Radiation Council prior to December 2, 1970. The budget authority adjustment is $42 million in 1970 and $14 million in 1971, and the related outlay adjustment is $37 million in 1970 and $17 million in 1971.

[7] Prior to Fiscal Year 1974 these funds were for the Atomic Energy Commission.

[8] Figures include expenditures for water and sewer programs and were not included in previous figures for these agencies.

[9] The large difference between outlays and budget authority is primarily due to outlays from budget authority prior to 1974.

[10] The large difference between outlays and budget authority is primarily due to TVA's outlays on remedial action which are funded from revenues rather than budget authority.

Source: Office of Management and Budget, *Special Analyses: Budget of the United States Government*, annual (Washington, D.C.: Government Printing Office, 1971–75).

Table 60

Federal Budgetary Authorities and Outlays for Environmental Protection and Enhancement, 1970–76

(In millions of dollars)

Activity	Actual										Estimates			
	1970[1]		1971		1972		1973		1974		1975		1976	
	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays
Financial aid to state and local governments														
Purchase, development, and operations														
City recreation			114	55	119	52	95	69	36	[2] 93	51	107	50	92
Preservation of unique natural areas and protection of endangered species			27	14	31	21	22	19	<1	[2] 25	<1	24	3	26
Noncity general recreation			139	52	206	78	140	84	59	121	142	123	147	136
Sport fish and wildlife programs			51	45	57	56	71	66	75	68	85	83	89	86
Historic preservation and rehabilitation			7	2	12	7	12	9	12	11	20	17	20	20
All other state and local aid			1	1	2	1	2	1	12	15	13	30	22	50
Subtotal	252	214	339	168	427	215	340	248	194	333	311	383	331	410
Direct federal activities														
Purchase, development, and operations														
City recreation			33	30	51	42	52	46	103	108	138	121	117	113

Preservation of unique natural areas and protection of endangered species			96	78	163	114	202	155	131	151	169	136	211	183
Noncity general recreation			231	227	150	127	190	172	127	128	185	179	180	179
Sport fish and wildlife programs			100	100	110	99	115	110	61	62	72	65	70	67
Historic preservation and rehabilitation			35	34	53	36	57	53	37	41	67	52	55	46
All other direct federal activity			37	37	114	85	38	36	50	48	73	75	73	72
Subtotal	376	339	531	506	641	509	653	571	509	537	703	626	706	660
Total	628	553	870	674	1,068	718	993	820	702	870	1,014	1,009	1,036	1,070

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[1] The breakdown by activity for fiscal year 1970 is different than that for the succeeding fiscal years. The 1970 breakdown is (in millions of dollars):

	Budget authority	Outlays
Financial aid to state and local governments		
Purchase of recreation and open space lands	80	51
Development of recreational areas, related activities	55	53
Protection of historic properties	3	2
Preservation of fish and wildlife	51	45
Beautification (e.g., highways)	62	62
Subtotal	252	214

	Budget authority	Outlays
Direct federal activities		
Purchase of nationally important areas	85	68
Development of recreational facilities, related activities	158	163
Protection of historic properties	1	1
Park roads and trails	56	34
Preservation of fish and wildlife	66	63
Beautification	10	10
Subtotal	376	339
Total	628	553

[2] Outlays are from budget authority prior to Fiscal year 1974.

Source: Office of Management and Budget, *Special Analyses: Budget of the United States Government*, annual (Washington, D.C.: Government Printing Office, 1971–75).

Table 61

Federal Budgetary Authorities and Outlays for Understanding, Describing, and Predicting the Environment, 1970–76

(In millions of dollars)

Activity or agency	Actual										Estimates			
	1970		1971		1972		1973		1974		1975		1976	
	Budget authority	Outlays	Budget authority	Outlays	Budget autonrity	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays	Budget authority	Outlays
Activity														
Observe and predict weather and ocean conditions, disturbances														
Research and development	120	105	193	163	146	139	145	135	169	150	173	153	207	177
Operations	299	305	284	287	256	241	321	317	341	334	377	358	388	371
Locating and describing natural resources														
Research and develop-	100	95	172	156	163	157	139	130	142	120	189	176	192	189
ment operations	61	60	70	66	63	65	127	120	143	140	174	176	188	184
Physical environmental surveys														
Research and development	4	4	6	6	10	8	14	10	14	16	13	11	11	8
Operations	54	54	81	76	96	92	96	93	107	99	126	117	122	115
Weather modification	12	12	17	17	18	16	18	17	22	22	22	23	21	22

Research on environmental impact on man	26	25	33	29	54	47	79	66	97	96	117	120	129	130
Ecological and other basic environmental research	44	41	58	56	81	74	68	66	94	89	108	101	122	115
Total	719	702	914	856	887	839	1,008	956	1,129	1,065	1,298	1,236	1,379	1,309
Agency														
Commerce	193	190	248	237	212	188	282	281	331	330	370	354	384	346
Defense—Military	178	178	176	161	160	156	146	141	151	135	164	141	166	146
National Science Foundation	60	61	94	83	118	106	107	97	112	106	120	113	140	126
Interior	103	102	116	115	134	131	152	142	162	151	234	229	247	240
National Aeronautics and Space Administration	87	75	171	157	150	144	142	127	117	89	115	101	128	119
Agriculture	51	51	56	57	56	59	109	103	114	115	130	133	134	133
Energy Research and Development Administration	—	—	—	—	—	—	—	—	65	65	87	86	101	101
Health, Education, and Welfare	17	17	20	19	26	24	31	26	28	28	28	31	28	29
Transportation	17	17	14	10	14	14	23	23	18	18	15	14	17	16
Smithsonian Institution	9	8	11	11	8	8	8	8	11	10	13	12	12	13
Other	3	2	8	6	9	9	8	8	19	18	23	22	23	23
Total	719	702	914	856	887	839	1,008	956	1.129	1,065	1,298	1,236	1,379	1,309

Source: Office of Management and Budget, *Special Analyses: Budget of the United States Government*, annual (Washington, D.C.: Government Printing Office, 1971–75).

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CHAPTER 4

ENVIRONMENTAL ECONOMICS

The U.S. economy has been experiencing severe economic problems over the past few years. Inflation, unemployment, and capital scarcities have affected everyone. These difficulties have focused attention on the economic effects of government programs. Environmental programs in particular have come under close scrutiny in their effects on both jobs and prices. The changed economic climate makes it more important than ever to subject these programs to rigorous economic analysis.

From its beginning, the Council on Environmental Quality has devoted much attention to assessing costs and economic impacts of environmental programs.[1] And in its 1973 Annual Report CEQ proposed a framework for carrying out environmental economic analyses. It divided environmental costs into four categories—damage costs, avoidance costs, abatement costs, and transactions costs—and discussed how these different costs should be taken into account in making environmental policies. This chapter extends and expands our 1973 discussion.

Damage costs are those resulting from damages that pollution causes, for example, blighted crops, ill health, higher death rates.

Avoidance costs are the financial costs and the other economic and social costs of attempts to avoid pollution-caused damages. They may vary from spending for an air-conditioner to the many kinds of costs associated with people moving away from polluted central cities.

Abatement costs are the value of the resources devoted to reducing the amount of pollution plus any indirect adverse effects of these expenditures on economic growth, employment, and production.

Transactions costs include the value of the resources used in the research, planning, administration, communication, and monitoring for pollution control.

Our present pollution control policies are attempting to reduce substantially damage and avoidance costs by increasing abatement and transactions costs. From the strict viewpoint of economic efficiency, the goal of our environmental policies should be to minimize the sum of the four types of costs—to continue to spend additional resources on abatement and transactions so long as the last increment of such expenditures purchases at least an equivalent value in reduced damage and avoidance costs.

This is the rigorous criterion for ensuring that resources are allocated efficiently. In practice, however, it is neither possible nor desirable to use only this criterion in designing and implementing programs. It is not possible because many of the costs, particularly those related to environmental damages, cannot be expressed adequately in monetary terms. There is no satisfactory method for calculating the true cost of a death. It is not necessarily desirable because there are a number of other factors, not easily incorporated into traditional benefit-cost calculus, that are important and sometimes overriding considerations in formulating environmental policies. Preventing irreversible damages is one such consideration, for example, the preservation of rare species and ecosystems from becoming extinct.

Another hard-to-balance factor involves how the various costs are distributed. Should the wealthy pay the avoidance costs and the poor the damage costs? Should people living in the western United States suffer higher damage costs from strip mining so that Chicago can have cheaper coal-fired electricity? Should the present generation pay high abatement costs so that future generations can enjoy a better environment? Such distributional issues are not adequately reflected in traditional benefit-cost analysis, but they are very important in formulating environmental policies.

One should not conclude, however, that economic analysis does not have an important role in formulating environmental policies. The goal is still to minimize the sum of damage, avoidance, transactions, and abatement costs subject to such unquantifiable considerations as mentioned above. If gaps remain in our knowledge about the magnitude of the various costs, it is nevertheless important to use the information that is available to arrive at a balanced assessment of how the total costs could be reduced and our programs made more efficient.

In the past, CEQ Annual Reports have concentrated on estimates of abatement costs expected to result from federal environmental legislation and on the resulting economic impacts. But abatement costs are only one part of the issue; looking only at them gives a very unbalanced picture.

In addition to aesthetic costs, smog causes damage to health, materials, and vegetation. Downtown Boston is shown here.

This year we set forth to rectify the imbalance by presenting similarly extensive analyses of damage, avoidance, and transactions costs. Unfortunately, there is still simply too little information available to provide the balance needed. Abatement costs have been quantified extensively, but too little is known about damage costs for them to be estimated with reasonable confidence. Some information is available on transactions costs, but almost no estimates have been made of avoidance costs.

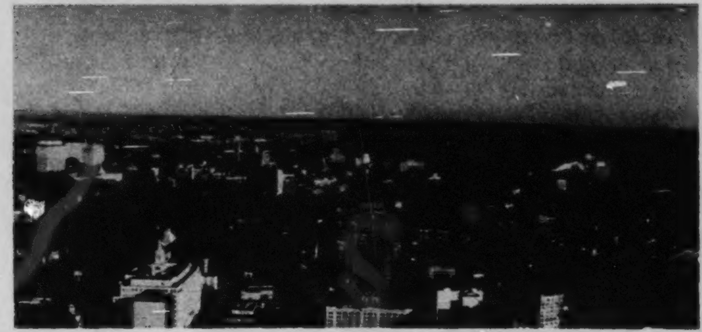
It is disturbing to remain in such a state of ignorance about the various costs and benefits associated with programs to safeguard the environment. Although as a nation we are committed to large expenditures, we do not know whether we are spending too much or too little.

This chapter attempts to summarize what we do know about these costs, how this information compares with what we should know, and how likely we are to get from where we are to where we should be. The next section discusses damage costs estimates. The second section presents available data on past abatement and transactions costs and CEQ's estimates of what they will be over the coming decade. The last section illustrates how the concepts and information presented, even though incomplete, may be used to make better decisions on such environmental issues as energy facility siting that the nation is facing.

ESTIMATING DAMAGE AND AVOIDANCE COSTS

DAMAGE COSTS

There are four stages involved in estimating the economic costs of pollution damages.[2] As indicated in Figure 1, pollutants are emit-



ted; the emissions affect ambient environmental quality, which in turn causes damages, which have economic costs, some of them quantifiable.

Uncertainty begins at the very outset—that is, with how much pollution there is and what types of pollutants are being emitted. EPA's permit programs are providing more hard data on pollution emissions, but many of our estimates are still based on "typical" production processes with "typical" emissions. As with most such estimates, probably very few situations correspond to the typical.

Uncertainty increases at the next step, ambient conditions. The science of predicting ambient quality remains inexact despite efforts to describe mathematically the processes by which pollutants disperse, become assimilated, degrade, and combine with other chemicals. There is little sure knowledge about how pollutants interact with each other and with other chemicals in the environment. For example, the roles of nitrogen oxides and hydrocarbons in the creation of photochemical smog are not well-understood. nor is the relationship between sulfur dioxide emissions and ambient sulfate levels, nor is the correlation between plant nutrients and the rate of eutrophication under the particular conditions of a given lake.

How much damage occurs is perhaps the most difficult thing to ascertain. Pollution is known to affect health, but there is little idea of how much. We know that lead can damage health, but we are unsure how much airborne lead enters the human bloodstream or the degree to which it impacts human health.[3] Given the myriad genetic, socioeconomic, and environmental factors that affect health, it is usually impossible to prove beyond doubt that a particular pollutant—SO_x from a powerplant, for example—causes health damage, much less how the damage may vary with exposure. And yet we know much more about such questions than we do about intangible and psychological damages, how noise affects people's well-being, for instance.

Materials damages are easier to measure, but even here it is difficult to deal with synergistic and antagonistic effects—the interactions of pollutants with each other and with other environmental components to cause more, less, or other damage than they do alone. Sulfur dioxide alone causes little if any damage to many materials, but with water it can form sulphuric acid whose effects can be severe. The most controversial step is the last one, placing a value on the damages that occur.

Estimating the dollar cost of painting a pollution-soiled building or of replacing ruined crops is relatively straightforward. But the value of a human life or of a clear sky, or of a place for recreation, or of a species which contributes to the diversity, complexity, and stability of an ecosystem cannot be fully translated into dollars. To the extent that we can quantitatively estimate damage costs with reasonable confidence, the easier it will be to make efficient environmental decisions. We must keep in mind, however, that this procedure often understates the full magnitude of the damages and usually ignores important issues concerning their distribution. When lives are translated into dollars, a great deal is lost in the translation.

Even if we cannot make rigorous quantitative estimates of damage costs, we should be using all the information that we have in making environmental policies. We have committed ourselves to a thoroughgoing program of reducing environmental damages. It is important to carry out this program as efficiently as we can.

The purpose of the following discussion is to summarize the state of our knowledge about damages. We are particularly interested in damage functions—the ways in which damages change with different levels of pollution. There is reason for this emphasis. The fundamental decision that we shall have programs to improve environmental quality is not in question. The crucial question today is not whether to improve the environment, but how much. How much will we gain by increased expenditures, and what are the tradeoffs?

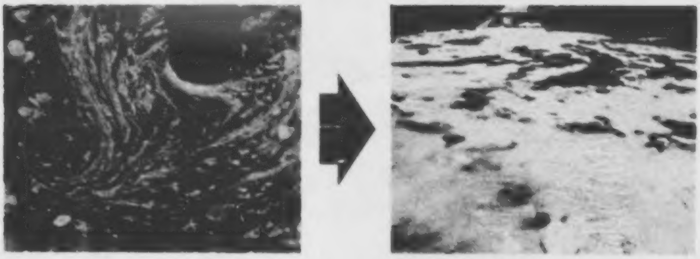
Damages to Health

All kinds of pollution—air, water, solid waste, radiation, noise—affect health. Chapter 1 discusses recent concern about the possibility of pollutants' causing cancer. Noise has been correlated with hearing loss and various psychosomatic disorders.[4] But air pollution has received the most attention.

Air pollution has been linked to many diseases, especially respiratory and heart ailments. Many studies of air pollution and health attempt to relate statistically human mortality or morbidity with concentrations of various pollutants. Some relate the differences in mortality rates among cities to socioeconomic variables as well as pollution concentrations.[5] Others relate day-to-day variations in deaths and hospital admissions to variations in pollution levels.[6]

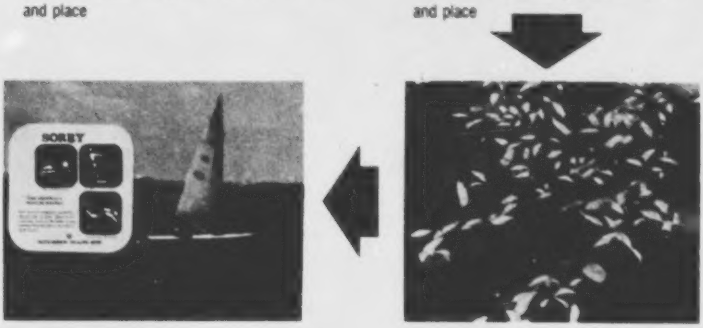
Figure 1

Estimating Damage Costs



Emissions
Gallons of raw sewage or tons of sulfur dioxide, etc. emitted at particular time and place

Ambient conditions
Parts per million of dissolved oxygen or sulfur oxides, etc. at a particular time and place



llar costs
Value of dead fish and cost of ill health, etc.

Damages
Thousands of dead fish or cases of bronchitis, etc.

A serious problem with these studies is the difficulty of separating air pollution from other factors that could be causing the observed illnesses. High sulfur dioxide levels are often associated with high concentrations of other pollutants as well as with low incomes, poor diet, urban congestion, and numerous other factors that contribute to disease and death. High SO_x levels often accompany weather conditions such as heat waves that alone would threaten the health of susceptible individuals. A recent Portland, Oregon, study incorporating 15 factors which may influence disease rates was unable to determine consistently significant relationships with any one variable even though they may all have been important.[7]

One way to overcome the problem is to select samples in which most of the other factors influencing health are constant. EPA's Community Health and Environmental Surveillance System program (CHESS) is studying communities with different pollution

Stack gas emissions killed trees 15 miles away from an industrial complex in the southern Appalachians.

levels but similar socioeconomic characteristics in order to isolate the effects of pollution on human health.[8] Other studies measure the effects of pollution on particular groups: older persons, children, or highly susceptible persons, such as those suffering from heart or respiratory diseases. Studies of illness in particular occupational groups such as insulation workers provide similar information about the impacts of high concentrations of particular pollutants on health.[9]

Few health studies have progressed so far as to estimate the shape of the damage function, and there is some controversy about this. Most analysts assume that it slopes upward—that each additional unit of pollution causes more health damage than the previous unit. But there is disagreement on whether there is some positive level of pollution at which no damage occurs (an implicit assumption in the definition of primary air quality standards), whether the damages increase at an increasing rate, and whether there is some maximum amount of damages that will occur regardless of the pollution level.

Even if we can obtain good estimates of health damages, there remains the problem of placing a dollar cost on sickness and death. Researchers commonly compute the costs of sickness and death as the present value of lost earnings plus the costs of medical treatment, absenteeism and/or burial.[10] This procedure ignores some most important costs of illness and death—the suffering of the patient and the anxiety or grief of a bereft family. Table 1 summarizes selected studies of health costs.

Damages to Materials

There have been numerous studies of the effects of air pollution on such materials as zinc, steel, rubber, paints, textiles, concrete, plastics, brick, wood, paper, and leather.[11] The analyses are generally based on consultations with manufacturers, empirical (often subjective) observations, and controlled laboratory experiments. Damages from water pollution to boat hulls, bridges, and waterfront structures have also been studied.[12]

Most investigations of the costs associated with soiling of materials are field studies of particular communities, providing piecemeal and widely varying results that made it difficult to estimate national soiling costs.[13]

The best studies of how chemical deterioration varies with pollution are laboratory studies which vary both the concentration of pollutants and other ambient factors which may interact with the pollutants. These analyses generally show that the amount of damage increases with the concentration of pollution and length of exposure time. Unfortunately they have been completed for only a limited number of materials and pollutants. Further, it is difficult to generalize real world conditions from laboratory results. Other studies which use real world observations to estimate deterioration of structures and materials are less precise because of the difficulty in isolating the effects of pollution, but they provide important verification.

Converting physical damage to materials into dollar values is relatively straightforward. Deterioration costs are most often estimated on the basis of either the cost of replacing the material or the cost of avoiding the damage. Some cost estimates are provided in Table 2.

Damages to Vegetation

Virtually all the studies of vegetation damage focus on air pollution, which reduces both quality and yield of commercial crops and lowers the aesthetic value of other plants.

Vegetation damages are estimated either by controlled experiments for particular pollutants and crops or by field studies conducted by agricultural specialists. As with materials, the most accurate information is obtained from the controlled experiments, but it is difficult with long-lived plants to measure how the effects vary with age or length of exposure. Most of these studies show damages increasing with amount of pollution and length of exposure, although the rate of increase tends to level off in both cases.[14]

Estimating the economic value of these damages is more difficult than with nonliving materials but is still fairly straightforward. Commercial crops should be valued at their market value less all market-

Many of the costs of environmental degradation, though very evident, are difficult to quantify.

ing and harvesting costs. Ornamental plants may be valued at their replacement cost, although owners may not consider replacement worthwhile, indicating that for them the damage costs are less than replacement costs. Table 3 summarizes several studies on vegetation damage costs.

Damages to Animals

Air pollution has been blamed for the poor health of livestock and zoo animals.[15] Water pollution affects aquatic life—either by direct poisoning or by depleting the oxygen supply and destroying food sources. Pesticides may contaminate and kill birds and fish. Man also affects wildlife by destroying its habitat as urbanization and agricultural development encroach upon wetlands and other natural areas.

Rarely is all wildlife destroyed by pollution or habitat change. Usually one species or ecosystem is replaced by another. For example, as thermal pollution raises the temperature of a stream, the trout are usually replaced by warm water fish like bass, and at yet higher temperatures these may be replaced by carp. The particular species which appear and the change in total biological productivity depend on many factors other than the water temperature. Although there is some knowledge of such effects, there is very little information about the relative value of the new and old species and therefore no basis for estimating how the damage function might look.

The economic value of commercial fish and animals that are killed by pollution may be estimated by subtracting the costs of catching and marketing from market prices.* For those that are affected but not killed, the economic cost is the cost of treating pollution-caused illness plus the reduction in market prices because of lower weights, lower quality, and so on.

Methods for valuing sports fish and wildlife rely primarily upon estimating what a sportsman would be willing to pay (in addition to the cost that he actually incurs) for the opportunity to catch the fish or kill the deer. Table 4 shows some of the wildlife values that have been estimated in such studies. Nongame wildlife also clearly has value. People either individually or through government spend considerable amounts to attract, view, and preserve wildlife. And there is the important ecological principle that greater diversity makes for greater stability in an ecosystem. When many species are replaced by a few that can withstand pollution, the system has become simpler and is likely to be less stable and robust.

Recreational Damages

Air pollution has an effect on active recreational activity,[16] but water pollution is probably a more important influence. As water quality drops, lakes, streams, and coastal areas are closed first to swimming, then to fishing, and finally to boating. Yet there has been little systematic collection of empirical evidence on how sensitive recreational use is to water quality.[17]

Economists have tried to predict the amount and value of the recreational use of water bodies if they were cleaned up. In general, the value of a site is a function of its distance from potential users, alternative sites nearby, the attractiveness of its facilities and beaches, the amount of water, and so forth. The same factors determine the value of increased or decreased recreation. Because the use of most water bodies is free or very inexpensive, it is hard to know how much people would be willing to pay if required to do so.

In planning federal water resource projects, the standard method is to place an arbitrary value, which varies from one type of activity to another, on each "user-day" of activity at a site.[18] Another technique is to estimate the value of a new site by observing how much people are willing to pay (in terms of travel costs, for example) for similar facilities.[19] Either way, the methods are controversial and the data poor. Regional studies often include estimates of regional economic activity generated by increased recreational expenditures. From a national perspective, these secondary benefits are often of questionable validity. The increase in economic activity in one region may only represent a diversion of this activity from some other location. The area from which the activity is diverted suffers a loss which roughly corresponds to the gain in the other area.

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*This estimate may be low for commercial fish because if a substantial portion of the population is killed, it may cost more to catch the remaining fish.

Table 1

Summary of Selected Studies on Health Damage Costs

Study	Pollutants	Diseases studied	Effects observed	Estimated cost of effects for U.S. in millions of dollars per year	Method of estimation
Ridker (1967)	General air pollution	Lung cancer, chronic bronchitis, acute bronchitis, emphysema, asthma, pneumonia	Higher urban mortality rates for these diseases	360–400	Total costs of these diseases computed to include lost earnings, early burial, treatment, and absenteeism; based on urban–rural mortality differentials, 18–20 percent of costs attributed to air pollution
Lave and Seskin (1970)	Particulates, sulfates	Bronchitis, lung cancer, other cancer, pneumonia, infant mortality	Increased mortality	2,080 (mortality and morbidity)	Multiple regression analysis across U.S. and British cities; various other variables used to explain mortality rates, including temperature–humidity, age, and race
Justus, Williams, and Clement (1973)	Particulates, sulfur dioxide, nitrogen dioxide, oxidants, carbon monoxide	Respiratory disease (nonrespiratory diseases assumed to be unaffected by pollution)	Mortality and morbidity	62–311	Respiratory disease costs taken from Ridker (1967); based on literature search, 95–99 percent of costs assigned to nonpollution factors such as smoking
Jaksch and Stoevener (1974)	Airborne suspended particulates (other pollutants not measured)		Statistically significant increase in number of hospital outpatients during and immediately after high pollution days	(1)	Multiple regression analysis; 14 other variables included, such as age, sex, and temperature–humidity; overall explanatory power (R^2) of equations is low

Singley et al. (1974)	Bacteria in drinking water	Salmonellosis, shigellosis, hepatitis	Bacteria count in water supply has statistically significant effect on reported cases	145	Multiple regression analysis across counties of reported diseases that could be caused by water; other explanatory variables include population density, age distribution, and income; dollar cost assigned to each case—i.e., $184 for one case of salmonellosis
Abel, Tihansky, and Walsh (1975)	Diseases carried in drinking water	Various	Mortality and morbidity	644	Tabulated reported cases attributed to water, estimated number of unreported cases, assigned a dollar value to each case, i.e., $1,250 for one case of salmonellosis
Page, Harris, and Epstein (1975)	Chlorinated hydrocarbons in drinking water	Cancer	Statistically significant relationship between use of chlorinated Mississippi water and various cancers	(1)	Multiple regression analysis across Louisiana parishes; other explanatory variables include median family income and fraction of work force in petroleum and coal products industries

[1] No national estimate.

Sources: R. G. Ridker, *Economic Costs of Air Pollution: Studies in Measurement* (New York: Frederick A. Praeger, 1967); L. B. Lave and E. P. Seskin, "Air Pollution and Human Health," *Science*, 169 (August 21, 1970) pp. 723–33; C. G. Justus, J. R. Williams, and J. D. Clement, *Economic Costs of Air Pollution Damage*, prepared for Southern Services, Inc., Birmingham, Alabama, by Science Technology and Research, Inc., Atlanta, May 1973; John A. Jaksch and Herbert H. Stoevener, *Outpatient Medical Costs Related to Air Pollution in the Portland, Oregon Area*, EPA 600/5–74–017 (Washington: Government Printing Office, 1974); J. Edward Singley et al., "A Benefit/Cost Evaluation of Drinking Water Hygiene Programs," prepared for the Environmental Protection Agency (preliminary, 1974); Fred H. Abel, Dennis P. Tihansky, and Richard G. Walsh, "National Benefits of Water Pollution Control," Environmental Protection Agency (1975); Talbot Page, Robert H. Harris, and Samuel P. Epstein, "Relation between Cancer Mortality and Drinking Water in Louisiana" (mimeo, 1975).

Table 2

Summary of Selected Studies on Materials Damage and Avoidance Costs

Study	Pollutant	Affected material	Damaging effect	Avoidance effect	Estimated damage cost, in millions of dollars per year	Estimated avoidance cost, in millions of dollars per year	Method
Mueller and Stickney (1970)	Ozone	Rubber products	Early replacement	Pollution-resistant materials	226	170	Literature search, questionnaire
Robbins (1970)	H_2S, SO_2, organic gases, particulates	Electrical contacts	Corrosion, fouling	Plating, air conditioning	15	50	Literature search and consultation with manufacturers
Salmon (1970)	Not specified	Miscellaneous	Accelerated deterioration	(1)	3,800	(1)	Literature search, interviews with manufacturers and users
Salvin (1970)	NO_x and ozone	Textile fibers and dyes	Fading and yellowing	Research, quality control, more expensive dyes and textiles	[2] 206		Consultations with industry
ITT (1971)	Not specified	Electrical components	Component failure	Air filtering, etc.	13.2	2.4	Literature search, interviews with manufacturers and users
Fink, Buttner, and Boyd (1971)	Sulfur oxides and other pollutants	Susceptible metal products	Accelerated corrosion	Extra protection and maintenance	[2] 1,450		Engineering-economic
Spence and Haynie (1972)	Particulates, sulfur oxides	Paints	Loss of service life	(1)	704	(1)	Literature survey
Gillette (1973)	Sulfur oxides	Metals and paints	Accelerated corrosion	Extra protection and maintenance	[2] 400		Engineering-economic

[1] No estimate made of avoidance cost.

[2] Includes both damage and avoidance costs.

Source: T. E. Waddell, *The Economic Damages of Air Pollution*, EPA-600/5-74-012 (Washington, D.C.: Government Printing Office, 1974).

Table 3

Summary of Selected Studies on Vegetation Damage Costs

Study	Location of study	Pollutants	Type of vegetation	Damage costs, in millions of dollars per year	Method
Lacasse and Weidensaul (1970)	Pennsylvania	(In descending order of importance) Oxidants, sulfur oxides, lead, hydrogen chloride, particulates, herbicides, ethylene	(In descending order of importance) Vegetables, fruits, agronomic crops, lawns, shrubs, woody ornamentals, timber, commercial flowers	11.0 (includes some avoidance costs)	Field observation
Benedict, Miller, and Olson (1971)	National	Ozone, peroxyacyl nitrates, oxides of nitrogen, sulfur dioxide, fluorides	Crops and ornamentals	Crops 85.6 Ornamentals 46.2 131.8	Assumed damage functions based on some published studies
Lacasse (1971)	Pennsylvania	(In descending order of importance) Oxidants, sulfur oxides, lead, hydrogen chloride, particulates, herbicides, ethylene	(In descending order of importance) Vegetables, fruits, agronomic crops, lawns, shrubs, woody ornamentals, timber, commercial flowers	0.22 (includes some avoidance costs)	Field observation
Millecan (1971)	California (15 counties)	(In descending order of importance) Ozone, peroxyacyl nitrates, fluorides, ethylenes, sulfur dioxide, particulates	Citrus and other crops	26	Field observation
Feliciano (1972)	New Jersey	(In descending order of importance) Peroxyacyl nitrates, ammonia, fluoride, particulates	Vegetables and field crops accounted for 85 percent of damages	1.19	Field observation
Naegele, Feder, and Brandt (1972)	New England	Oxidants accounted for over 90 percent of damages	Fruits, vegetables, agronomic crops	1.1	Field observation
Pell (1973)	New Jersey	(In descending order of importance) Oxidants, hydrogen fluoride, ethylene, sulfur dioxide, anhydrous ammonia	Agronomic and ornamental plantings	0.13	Field observation

Source: T. E. Waddell, *The Economic Damages of Air Pollution*, EPA-600/5-74-012 (Washington, D.C.: Government Printing Office, 1974).

Table 4

Summary of Selected Studies on the Value of Wildlife

Study	Species/location	Group receiving benefits	Unit benefit	Total benefit per year	Method
Davis (1964)	Big game/private forest in Maine	Hunters	Average benefit of $1.96 per household per day	$29,080 for 500,000-acre forest, about 9 percent of its value in logging	Onsite interviews
Brown and Hammack (1973)	Waterfowl/United States	Hunters	Marginal value of $3.10 to $4.65 per bagged waterfowl	(No estimate)	Mail-circulated questionnaire
Meyer (1974)	Salmon/Fraser River in British Columbia	Fishermen and nonusers	$632 per household per year for fishing plus $223 per household per year for preservation (value to nonusers)	$186 million for fishing plus $101 million for preservation	Household interviews
Horvath (1974)	Wildlife/ Southeastern United States	Hunters, fishermen, watchers, photographers	$2,183–3,107 per household per year for all uses	$24–31 billion for all uses	Household survey

Sources: Robert K. Davis, "The Value of Big Game Hunting in a Private Forest," *Transactions of the 29th North American Wildlife and Natural Resources Conference*, March 9–11, 1964 (Washington, D.C.: Wildlife Management Institute, 1964), pp. 393–403; Gardner Mallard Brown, Jr., and Judd Hammack, "Dynamic Economic Management of Migratory Waterfowl, *Review of Economic Statistics*, 55 (February 1973), pp. 73–82; Philip A. Meyer, *Recreational and Preservation Values Associated with the Salmon of the Fraser River*, Environment Canada, Fisheries and Marine Service, Info. Report Series PAC/N–74–1 (Ottawa); Joseph C. Horvath, "Economic Survey of Wildlife Recreation," Georgia State College, Environmental Research Group, 1974.

In general, recreational activities that make more intensive use of the water are assumed to have higher values than those that do not. Thus a day of swimming is considered more valuable than a day of boating, which is more valuable than a day of picnicking. However, in order to construct a damage function, we would need to estimate the number of days for which people would participate in each activity if the water were cleaner. The total benefit per person derived from a low-valued activity may be greater than that derived from a high-valued activity if the former is done often enough. No one has yet adequately combined data on relative participation rates with data on water pollution and with estimates of relative values of different activities in such a way as to allow an appropriate damage function to be constructed. There may also be significant distribution questions because the wealthy can drive long distances to sites having clean water (or belong to private clubs with swimming pools), whereas the city poor are more dependent upon urban water bodies for their recreation.

Aesthetic Damages

All the damages described earlier may also have aesthetic impacts. Further, air pollution reduces visibility, assaults the sense of smell, and destroys works of art and historical relics.

Tokyo residents count the number of days when they can see Mount Fuji, and Los Angeles residents similarly count the days when they can see Catalina Island.[20] Visibility is significantly restricted even by small amounts of air pollution, as indicated in Figure 2.

There are many cities where smog has destroyed or defaced works of art, rare books, and historical buildings; $4 million was recently

As water quality drops, beaches are closed first to swimming, then to fishing, and finally to boating. The pollution of Lake Erie has been widely publicized.

spent restoring the pollution-damaged facade of the New York City Hall.[21] The sculpture of Venice is crumbling from air pollutants and outdoor statues are losing their features.

Aesthetic damages caused by noxious odors have been documented in the courts and by opinion surveys.[22] Water pollution also causes aesthetic damage.[23] People often express displeasure at malodorous or unsightly waterways. And much of our concern about the solid waste problem relates to littering and unsightly dumps.

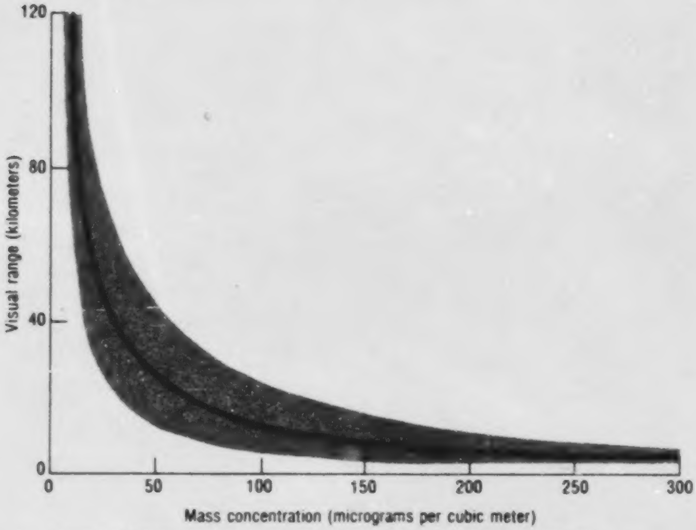
The value of aesthetic damages was at least partially included in some of the cost estimates given earlier. For example, the aesthetic costs of damages to ornamental plants are at least partially captured by the costs of replacement. The value may also be estimated by the cost of repair (e.g., cleaning the New York City Hall). The value of artistic and historical objects, however, lies in their uniqueness and irreplaceability. With rising incomes, education, and leisure in the United States, aesthetic damages may be expected to grow more important but no easier to quantify.

Other Damages

The foregoing discussion covers most damages that have been analyzed and to a limited extent quantified. But there are other dam-

Figure 2

Relationship Between Concentration of Particulates and Visibility



Source: U.S. Department of Health, Education, and Welfare, Public Health Service, *Air Quality Criteria for Particulate Matter* (Washington, D.C.: Government Printing Office, 1969), p. 57.

ages that have not been widely recognized and which defy satisfactory quantification.

There are "anxiety" costs. People are often concerned about the risk of damages even if objective assessments determine that the risk is slight. Local opposition to the siting of a nuclear powerplant is an example. There are costs related to "option demand." A person who does not use a lake and therefore is not identified as being affected by its degradation may still value the option to use it and therefore suffers a damage cost if deprived of that option. There are similar costs related to preservation demand. The destruction of African wildlife is disturbing to many people who never expect to have an opportunity to see it. Most of these costs are essentially unquantifiable except perhaps through surveys.

All the damage costs that are not quantifiable—these and others mentioned throughout the discussion—may be very important to supporters of more stringent environmental policies. Economists' calculations might show such policies to be "inefficient," but only because they neglect many such important costs.

AVOIDANCE COSTS

Environmental damages would be much worse if we did not act to avoid them. People install air filters in their homes to avoid respiratory disease, they cover unused clothing with plastic bags to prevent soiling, they travel long distances to find clean beaches, and

Many people would oppose the despoliation of areas such as the Merced River in Yosemite National Park although they may never visit them.

some ultimately move their homes at great expense to live in a clean environment.[24]

The costs of plating electrical contacts to avoid pollution corrosion are well-documented.[25] New York's Metropolitan Museum of Art was forced to coat statuary with beeswax and to air-condition exhibition areas.[26] Part of the U.S. Department of Agriculture's Research Center at Beltsville, Maryland, is devoted to developing pollution-resistant varieties of commercial plants. The list goes on and on; we do not know all the items, let alone their dollar values, although some estimates are provided in Table 2.

Recognizing at least the concept of avoidance costs is important to policy formulation. People act to avoid pollution damages. Those most disturbed by environmental degradation may be able to move to an unspoiled environment, often trading a higher salary for fresh air and quiet. This preference should be taken into account in making decisions. For instance, as the last section of this chapter points out, decisions about energy development may well result in locating heavily polluting facilities in areas where people have moved expressly in order to escape environmental degradation—indeed, where the damage costs to each person affected will be particularly high.

INDIRECT ESTIMATION METHODS[27]

The discussion so far has summarized efforts to estimate damage costs directly. But to the extent that people are aware of them, these costs should also be reflected indirectly in the market prices of labor and land. Everything else being equal, people will demand higher wages to work where pollution levels are high. Conversely, they will be willing to pay more for unpolluted residential and industrial sites in order to avoid pollution damages. This section discusses attempts to estimate damage costs indirectly by analyzing how prices and wage rates vary with environmental quality.

Estimating with Land Prices

Land prices are being used more and more in attempts to estimate the monetary value that people place on pollution damages. Among other advantages, property values can reflect many of the psychic costs that cannot be measured easily by other techniques. If an increment of pollution is small, if people and companies correctly perceive its damages, if they are able to move about freely (thus driving land prices in unpolluted places up until they are no more attractive than polluted places), then differences in land prices correctly measure the damages caused by the pollution increment. But these assumptions rarely hold true, so that the use of land prices to estimate damage costs is a very uncertain procedure. If scientists do not know all the damaging effects of pollution, how can the average person or firm fully perceive them? If people and firms move in re-

Depressed property values along polluted streams provide a measure of damage costs.

sponse to pollution differentials, they do so reluctantly, not freely, and they consider many other factors. If pollution is serious and pervasive, then prices other than those for land will be affected; they too must be assessed in order to reach an unbiased estimate of damages. For example, if pollution were to damage the Florida orange crop, reducing output and raising the price of oranges all over the country, we would underestimate total damage costs if we looked at Florida land prices alone. Some of the damages would be reflected in the higher prices of oranges.

Predicting the land price changes that will result from pollution abatement is also problematical. Many factors affect land prices. Everything is quite literally related to everything else. We have much to learn about these relationships before we can accurately predict the land price changes occurring in response to changes in environmental quality.

Empirical studies generally use simple statistical models which could only predict land price changes and measure benefits accurately for very small pollution abatement programs. Even with the simplified models there are data and statistical problems. Pollution effects seem small relative to the errors in the data. As with health damages, explanatory variables are generally correlated with each other so that the importance of one cannot be separated from the importance of others. If sulfur oxide levels and crime rates move together, for example, one cannot tell which affects property values. Table 5 summarizes some studies that relate land values to pollution levels.

Estimating with Wage Rates

Insofar as people perceive pollution damages, wage rates may also reflect increased pollution levels and may be used to estimate dam-

Table 5

Summary of Selected Studies Relating Air Pollution to Land Values

Study	Type of pollution	City studied	Effect on median value of housing	Estimated benefits
Ridker and Henning (1967)	Sulfation levels and suspended particulates	St. Louis (1960 census data)	−\$96,000 per mg/cm^3 of sulfation (particulates dropped from equation because of correlation with sulfation)	\$10–15 million per year in St. Louis for shift to low sulfur fuels
Anderson and Crocker (1971)	Sulfur oxides and suspended particulates	Washington, Kansas City, St. Louis (1960 census data)	A 10 percent rise in composite pollution implies a 1–2 percent drop in property value	\$300–700 per property for abating all air pollution
Wieand (1973)	Sulfur dioxide, sulfur trioxide, particulates	St. Louis (1960 census data)	No statistically significant effects observed	
National Academy of Sciences (1974)	Automobile-derived NO_x, HC, and O_x	Boston (1970 census data)	−\$205,200 per ppm of NO_x −\$146,356 per mg/cm of HC^3 −\$2,731,350 per unit change in O_x index	\$1.5–5 billion per year in the United States for implementation of Clean Air Act, as amended
		Los Angeles (1970 census data)	−\$17,015 per ppm of NO_x −\$24,869 per mg/cm^3 of HC −\$36,918 per unit change in O_x index	

Source: R. G. Ridker and J. A. Henning, "The Determinants of Residential Property Values with Special Reference to Air Pollution," *Review of Economic Statistics*, 49 (1967), pp. 246–57; R. J. Anderson, Jr., and T. D. Crocker, "Air Pollution and Property Values," *Urban Studies*, 8 (3) (October 1971), pp. 171–80; K. F. Wieand, "Air Pollution and Property Values: A Study of the St. Louis Area," *Journal of Regional Science*, 13 (1) (April 1973), pp. 91–95; National Academy of Sciences, National Academy of Engineering, *The Costs and Benefits of Automobile Emission Control*, Report to the U.S. Senate, Committee on Public Works (Washington, D.C.: Government Printing Office, 1974), pp. 221–42.

ages. The theory involved is similar to the theory of land value changes, but the assumptions are probably more tenuous.[28] Wage earners are assumed to move to more polluted areas only if offered higher wages. If all other things were equal, eventually wage level differences would reflect environmental differences and the higher wages would provide a measure of the higher damages.

A small attempt to relate recent metropolitan growth rates to indices of environmental quality is reported in the population section of Chapter 3. Another study estimated that the wage differential necessary to hold people in U.S. cities is equal to about 5 percent of GNP.[29]

The National Academy of Sciences used socioeconomic variables and the concentrations of particulates, sulfur dioxide, and nitrogen dioxide to attempt to "explain" wage differentials across cities.[30] Although this study encountered numerous statistical problems, it derived a crude estimate of $5 billion per year as the benefits (that is, reduced damage costs) that would result from a rollback in automobile emissions. There are sufficient uncertainties with this estimation technique that such estimates should be taken only as preliminary efforts.

ESTIMATING WITH SURVEYS AND BIDDING GAMES

To the extent that people perceive pollution damages and answer honestly, surveys and bidding games may be useful in estimating the value of environmental policies. There are plenty of drawbacks to these techniques, however. What questions a survey asks, and how they are asked, may have a powerful effect on the results. The fact of the survey itself affects perceptions of environmental problems. Answers to hypothetical questions about how much a person would be willing to pay for clean air, for example, may not be accurate because a respondent does not expect ever to have the choice in real life.[31] In spite of these problems, researchers have attempted to estimate the benefits of pollution abatement in the Four Corners region of the Southwest by asking people to bid for various levels of environmental quality, and they have attempted to determine willingness to pay for hunting, wilderness, and recreational areas through surveys.[32] Such attempts can provide useful information about people's preferences which is not easily obtainable otherwise.

RETROSPECT AND PROSPECTS

There is little encouragement in this assessment of attempts to estimate the damage and avoidance costs associated with environmental degradation. Too many conceptual and empirical problems remain to allow any but a very few limited estimates to be taken seriously. Perhaps even more discouraging, there is little evidence of progress; many studies just review previous studies. An occasional study provides some useful basic information, but researchers too often ignore the many uncertainties inherent in this work.

There have been several attempts to aggregate what is known about pollution damages into national damage cost estimates. Some of them are summarized in Table 6. The estimates were obtained by a variety of techniques, all with serious weaknesses. Most of the figures are lower bounds, but the National Academy estimate was intended as an upper bound. Some measure the damages of all pollution; others attempt to measure only the savings in damage costs that would be achieved by reducing pollutants to ambient standards. Some carefully attempt to distinguish between the impact of pollution and other contributing factors in terms of measured damages; others are more casual. Each is an honest attempt to summarize the author's view of what was known about damage costs at the time. But none is sufficiently accurate to serve as a basis for formulating public policy.

Although national damage cost estimates are useful for placing our environmental programs in perspective, they are not needed for the environmental policy decisions presently confronting the nation. As stated earlier, we are concerned not with whether there should be environmental programs but with how stringent these programs should be. For this answer we need to focus research more on identifying the individual damage functions than on estimating the aggregate damage costs.

The damage functions are determined by two primary factors. The first is how the amount of damage to each person, plant, animal, building, etc. is related to the amount of pollution. The second is how many people or things are exposed to the pollution. Chapter 3 briefly discussed damage functions. With respect to people affected, EPA has recently completed a study which provides valuable information on the demographic and socioeconomic characteristics of populations exposed to different pollution levels in the United States.[33] Of course, environmental degradation not directly affecting people is also a concern, but basically the magnitude of the damages is most strongly determined by the number and characteristics of people exposed.

The aggregate results of this study are shown in Figure 3. According to these results, most of the U.S. population in 1973 was not exposed to short-term particulate levels, short- or long-term sulfur dioxide levels, or short-term carbon monoxide levels exceeding the federal primary standards. However, significant proportions were exposed to long-term particulate and short-term oxidant levels exceeding the federal standards. Although the study covered only 68.6 percent of the 1970 U.S. population living in the 241 SMSA's for which adequate pollution data were available, it may reasonably be assumed that most of the people not included in the study (living in smaller SMSA's or outside metropolitan areas) also experienced pollution levels below the primary standard.

Table 6

Comparison of National Pollution Damage Estimates

Media	Study	Base year	Range, in billions of dollars
Air	Ridker (1966)	1970	7.3–8.9
Air	Gerhardt (1969)	1968	6.0–15.2 (best 8.1)
Air	Barrett and Waddell (1973)	1968	16.1
Air	Babcock and Nagda (1973)	1968	20.2
Air	Justice, Williams, and Clement (1973)	1970	2.0–8.7
Air	Waddell (1974)	1970	6.1–18.5 (best 12.3)
Air	National Academy of Sciences (1974)	1973	15–30 (best 20)
Air	Heintz and Hershaft (1975)	1973	9.5–35.4 (best 20.2)
Water	Abel, Tihansky, and Walsh (1975)	1970	5.5–15.5 (best 10.6)
Water	Horak and Heintz (1975)	1973	4.5–18.6 (best 10.1)

Sources: R. G. Ridker, "The Problem of Estimating Total Costs of Air Pollution: A Discussion and an Illustration," report to the U.S. Public Health Service, Washington, D.C., July 1966; P. H. Gerhardt, "An Approach to Estimation of Economic Losses due to Air Pollution," National Air Pollution Control Administration (mimeo, June 1969); L. B. Barrett and T. E. Waddell, "The Cost of Air Pollution Damages: A Status Report," AP–85 (Environmental Protection Agency, February 1973); L. R. Babcock, Jr., and N. L. Nagda, "Cost Effectiveness of Emission Control," *Journal of the Air Pollution Control Association* (March 1973), pp. 173–79; C. G. Justice, J. R. Williams, and J. D. Clement, *Economic Costs of Air Pollution Damage*, STAR CR-103, prepared by Science, Technology and Research, Inc. (for Southern Services, Inc., Birmingham, Alabama, May 1973); T. E. Waddell, *The Economic Damages of Air Pollution*, EPA–600/5–74–012 (Washington: Government Printing Office, 1974); National Academy of Sciences, National Academy of Engineering, *Air Quality and Automobile Emission Control*, Vol. 1, *Summary Report*, prepared for the Committee on Public Works, U.S. Senate, 93d Cong., 2d Sess., Ser. no. 93–24 (Washington: Government Printing Office, September 1974), p. 121; Fred H. Abel, Dennis P. Tihansky, and Richard G. Walsh, "National Benefits of Water Pollution Control" (Washington, D.C.: Environmental Protection Agency, 1975); H. T. Heintz, Jr. and A. Hershaft, "National Benefits of Controlling Air Pollution," and G. C. Horak and H. T. Heintz, Jr., "National Benefits of Controlling Water Pollution," prepared for the Environmental Protection Agency by Enviro Control, Inc., under contract no. 68–01–2821, 1975.

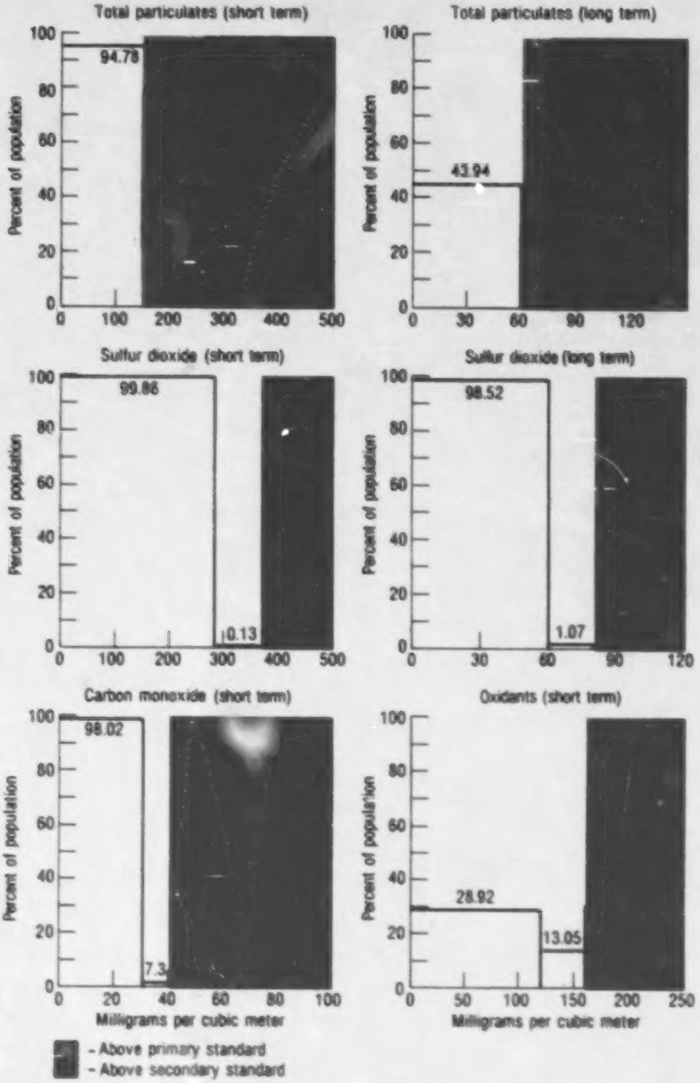
The study also shows how different age groups, races, income levels, and employment groups were exposed to different pollution levels. In most cases the distribution was very similar to that for the whole population. There was no consistent pattern across age groups; for particulates and CO the aged tended to be exposed slightly more than the average, and for sulfur oxides, the young slightly more. In terms of income groups, the poor tended to be exposed slightly more and the wealthy slightly less, and in terms of occupation, people working in manufacturing tended to be exposed more than others.

Of course, these estimates are only approximate because of the problems of accurately measuring pollution levels and of estimating pollution levels throughout a metropolitan area from a limited number of sampling stations. Any such study using existing data necessarily relates pollution levels to place of residence and does not

Figure 3

Percentage of Population Exposed to Various Levels of Air Quality

(in micrograms per cubic meter)



Source: Based on Enviro Control, Inc., "National Benefits of Controlling Air Pollution," prepared for the U.S. Environmental Protection Agency under contract No. 68-01-2821 (draft, May 1, 1975).

take account of exposures at the workplace. Nevertheless, the detailed data presented for each SMSA included in the study should provide valuable information for making policy decisions.

Such information on the number and characteristics of people affected by different pollution levels is an important input into environmental policy formulation and implementation. But it is only part of the input that is needed. Much more should be learned about how the damages are caused and how the amount of damage varies with the level of pollution. If the physical damages are identified properly, monetary values will be more accurate. And even if accurate monetary values cannot be assigned, decisionmakers will be provided with a better defined tradeoff between increased abatement costs and the resulting damages avoided. Natural scientists, engineers, economists, and sociologists must get together and think about how to generate this information in order to contribute most to the formulation of better policies.

ABATEMENT AND TRANSACTIONS COSTS

Abatement costs include the resources expended to reduce pollution and the net adverse economic impacts resulting from these expenditures. Transactions costs are the costs of planning and implementing environmental protection and improvement programs. Now that our environmental programs are a few years old, we are beginning to obtain empirical information on the magnitude of these costs. This section of the chapter reviews the information and updates projections for abatement costs in the coming decade.

PAST ABATEMENT COSTS

A major problem in comparing estimates of pollution abatement costs is that different cost definitions are used. One difference stems from the regulations to which the estimates relate. Both CEQ and EPA estimates pertain primarily to federal legislation and to the federal, state, and local regulations enacted to comply with the federal laws. In most instances we do not include the costs of meeting state and local standards when they are more strict than the federal. Other estimates usually include these additional costs.

A second problem is to distinguish between what is a pollution control expenditure and what is not. The costs of installing, maintaining, and operating an "end-of-the-pipe" device that has no function other than abating pollution are easy to identify. But more and more often pollution abatement is being integrated into the production process, where it may both reduce pollution and improve production efficiency. For example, oxygen bleaching rather than chlorine bleaching in papermaking can reduce water pollution problems and may lead to cost savings as well.[34]

The question is how much if any of the expenditure should be allocated to pollution abatement. The problem is more than theoretical. Under the Internal Revenue Code, pollution abatement devices may be financed with industrial revenue bonds—tax-free bonds carrying a low interest rate.[35] The Internal Revenue Service has the authority to determine whether the investment is for bona fide pollution control devices and has only recently developed a set of proposed regulations which explicitly provides guidelines for the use of industrial revenue bonds in financing investments that will both abate pollution and produce a salable product.[36]

A third definitional problem is whether to include all pollution abatement costs or just the additional expenditures required by law and government regulations. CEQ estimates both total and incremental costs but considers incremental costs the more meaningful estimate. (How the Council arrives at incremental cost estimates is described in the chapter appendix.)

Solid waste management provides a clear example of the difference. Even if there were no environmental legislation, we would not allow trash and garbage to pile up in backyards and streets but would pay to have it disposed of. It is unreasonable to attribute all these disposal costs to environmental legislation. However, there are some special costs that can and should be. For instance, open burning is prohibited in many areas pursuant to the Clean Air Act. These prohibitions increase solid waste collection and disposal costs because open burning in backyards or dumps was a fairly common, inexpensive practice in the past. Water pollution control requirements can also make solid waste disposal more expensive by requiring better construction and operation of landfills. These additional costs are included in the CEQ definition of incremental costs. Most surveys do not distinguish between total and incremental costs.

The Department of Commerce defines pollution control expenditures as the difference between what a firm is now spending on capital investment, operation, and maintenance for a plant and what it would be spending if no attempt were made to control pollution. Conceptually the Commerce estimates should be somewhat higher than CEQ's because businesses would be spending some money for pollution control even if there were no federal legislation.

Recognizing these definitional problems, this section summarizes and compares the estimates of past pollution abatement costs made by different organizations.

Industrial Costs

The Bureau of Economic Analysis in the Department of Commerce and McGraw-Hill Publications Company make independent estimates of how much industries are investing to abate pollution.

The Census Bureau has also begun an annual survey of industry investment for abatement devices and expenditures for their upkeep.

The McGraw-Hill data cover the longest time period; they have included in their last eight annual surveys of plant and equipment investment a question about what percentage of these expenditures is for pollution abatement. The estimates include expenditures that might have been made in the absence of government standards as well as spending to comply with standards.

We consider BEA's survey more accurate because it covers a larger sample of firms and more precisely states its questions regarding pollution control expenditures than McGraw-Hill.[37] For the 2 years that they cover, BEA's dollar estimates for investment in pollution control are lower than McGraw-Hill's—by 13 percent for 1973 and by 25 percent for 1974. One reason for this difference is that the McGraw-Hill estimates apparently include some items that BEA considers maintainence costs, not capital investments.[38]

Figure 4 shows McGraw-Hill's estimates of the total investment for pollution abatement by major industry sector between 1967 and 1974. Expenditures have risen steadily, in some cases at an accelerating rate. However, this has been a time of rapid inflation, so that the amount of real investment has increased much less rapidly than these dollar amounts would suggest. Figure 5 shows total investment in both constant and current dollars; real investment increased 365 percent from 1967 to 1974 while dollar expenditures increased 550 percent. According to BEA's surveys, real investment appears to have decreased slightly between 1973 and 1974.[39]

Figure 6 shows how the expenditures have been divided between air and water pollution abatement. Air pollution was generally absorbing an increasing share of total expenditures up to 1974 in anticipation of the 1975 deadlines established by the Clean Air Act. Water pollution control will probably absorb an increasing share as expenditures shift to meet the 1977 and 1983 requirements established by the 1972 Amendments to the Federal Water Pollution Control Act.

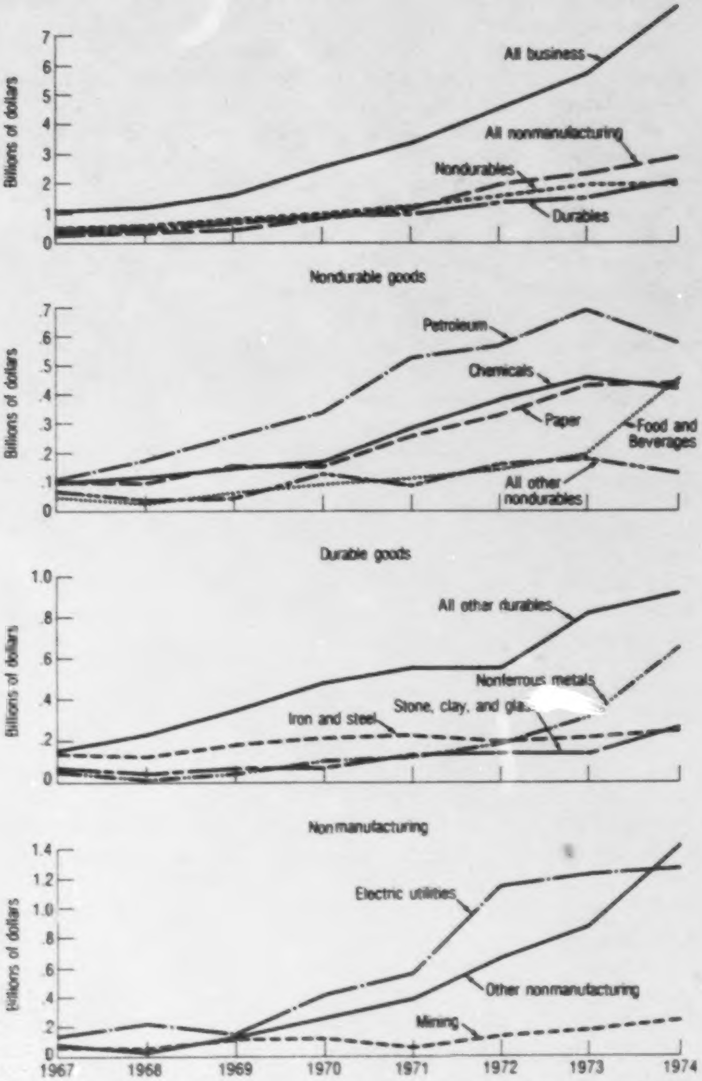
More interesting than dollar expenditures is the proportion of total capital investment allocated to pollution abatement; Figure 7 shows the proportions for 1970–74 based on the McGraw-Hill estimates. The share of plant and equipment investment devoted to pollution abatement has generally risen, but the increases were neither continuous nor rapid. Indeed, in several sectors there have been periods of net decrease or leveling off, particularly between 1973 and 1974. The McGraw-Hill figures show that pollution control accounted for a little more than 6 percent of total capital investment in 1974; the BEA figure is lower—at about 5 percent.

Both the BEA and McGraw-Hill surveys cover only investment costs for air and water pollution abatement. The Census Bureau survey covers solid wastes, noise, radiation, and pesticides as well as air and water pollution. BEA and McGraw-Hill include only invest-

Figure 4

Industrial Investments for Air and Water Pollution Abatement, by Sector, 1967-74

(in billions of current dollars)



Nondurable goods

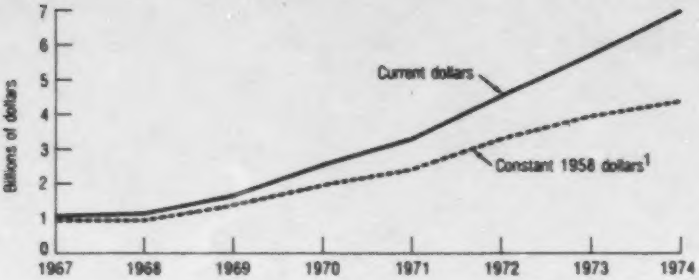
Durable goods

Nonmanufacturing

Source: McGraw-Hill Publications Company, "McGraw-Hill Survey of Pollution Control Expenditures," annual (New York: 1968-75).

Figure 5

Industrial Investments for Air and Water Pollution Abatement, All Business, 1967-74

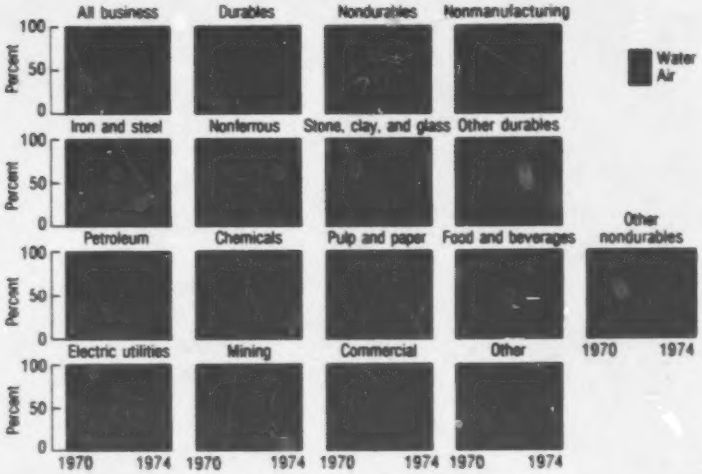


[1] The GNP deflator for nonresidential fixed investment was used to derive constant dollar expenditures.

Source: McGraw-Hill Publications Company, *"Annual McGraw-Hill Survey of Pollution Control Expenditures,"* annual (New York: 1968-75).

Figure 6

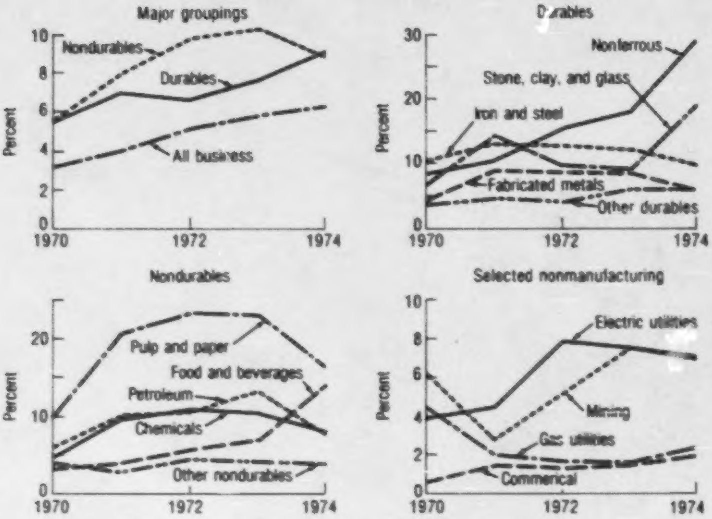
Percentage of Industrial Investments for Air and Water Pollution Abatement, 1970-74



Source: McGraw-Hill Publications Company, "McGraw-Hill Survey of Pollution Control Expenditures," annual (New York: 1971-75).

Figure 7

Industrial Pollution Abatement Investments as a Percentage of Total Plant and Equipment Investments



Source: McGraw-Hill Publications Company, "McGraw-Hill Survey of Pollution Control Expenditures," annual (New York: 1971-75).

ments made by businesses while the Census Bureau includes operation and maintenance costs and estimates all costs for governments and consumers as well as business. Results of the Department of Commerce test survey are given in Table 7. In 1972 industry spent approximately $6.7 billion for pollution abatement—$4 billion (60 percent) for investment ($3.9 billion for air and water pollution control) and the rest for operation and maintenance. These investment estimates are about 13 percent lower than the 1972 McGraw-Hill estimate for air and water pollution control investment.

Automobile Abatement Costs

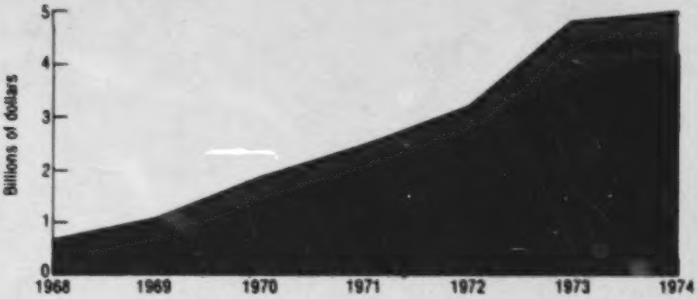
Cost estimates for automobile emissions control are compared in Table 8. They all agree reasonably well, but the reader should recognize that a small unit cost difference can make a substantial difference in total abatement costs.

Figure 8, using EPA unit cost estimates, shows total annual costs of abating automobile emissions since 1968, when the federal program began. It is noteworthy that the investment and maintenance costs combined are less than the cost of the extra fuel consumed by autos equipped with pollution control devices. We expect these fuel

Figure 8

Costs of Automobile Pollution Abatement, 1968-74

(in billions of December 1974 dollars)



penalty costs to decrease, both relatively and absolutely in future years.

Public Abatement Costs

Governments spend money to lessen or avoid environmental damages, to stop pollution, and to design and implement environmental policies. Although it is difficult to distinguish among these expenditures, it is clear that most government environmental expenditures are for pollution abatement. The water pollution control grants program is the second largest federal public works program (highways are first), and it may soon become the largest capital expenditure item in local government budgets.

Federal expenditures for pollution abatement from fiscal years 1958 through 1974 are shown in Figure 9. (Before 1969 expenditures were much lower, although no comprehensive estimates are available.) The largest portion of current federal spending for pollution abatement is given as grants to other levels of government. About 10 percent is directed to reducing pollution from federal facilities.

State pollution abatement expenditures are very small. They are made primarily at state-owned hospitals, schools, parks, and the like or as grants to localities for pollution control. These expenditures are included with local spending.

Local pollution abatement expenditures are primarily for municipal waste water collection and treatment, collection and disposal of solid wastes, and abatement of air pollution from incinerators and other publicly owned facilities. There are four major sources of data on these expenditures— three from the Department of Commerce and the fourth from EPA.[40]

The largest abatement cost is for building waste water collection and treatment facilities. Figure 10, the top section, shows how these

Table 7

Bureau of Census Estimates of Total National Pollution Control Expenditures, 1972 [1]

(In millions of dollars)

Line		Total	Air	Water	Solid waste	Other and unallocated [2]
1	National expenditures for pollution abatement and control (2+16+19)	18,738	6,537	8,590	2,718	893
2	Pollution abatement (3+6+12)	16,802	6,279	8,365	2,691	−533
3	Personal consumption (4+5)	1,922	1,922	—	—	—
4	Durable goods	477	477	—	—	—
5	Nondurable goods and services	1,445	1,445	—	—	—
6	Business (7+8) [3]	8,999	4,233	4,244	1,059	−536
7	On capital account	4,982	2,426	2,411	145	—
8	On current account (9+10+11)	4,017	1,806	1,833	914	−536
9	Private purchases	3,370	1,716	726	914	14
10	Government enterprise purchases	1,198	91	1,107	—	—
11	Costs recovered	−550	—	—	—	−550
12	Government (13+14+15)	5,880	124	4,121	1,632	3
13	Federal purchases	452	45	401	4	3
14	State and local purchases	1,880	—	252	1,628	1
15	Government enterprise purchases of fixed capital	3,547	80	3,468	—	—
16	Regulation and monitoring (17+18)	351	139	133	13	67
17	Federal purchases	201	48	79	9	65
18	State and local purchases	150	91	55	3	2
19	Research and development (20+21+22)	1,585	119	92	15	1,359
20	Private purchases	1,279	—	—	—	1,279
21	Federal purchases	208	114	34	5	55
22	State and local purchases	98	5	58	9	25
	Addendum: Capital consumption allowance for business	571	—	—	—	—

[1] Preliminary; details may not add to totals because of rounding. Excludes agricultural business; real estate operators; medical, legal, educational, and cultural service; and nonprofit organizations.

[2] "Other" includes expenditures for noise, radiation, and pesticide pollution control. "Unallocated" includes business expenditures for air, water, and solid waste pollution control not assigned to media.

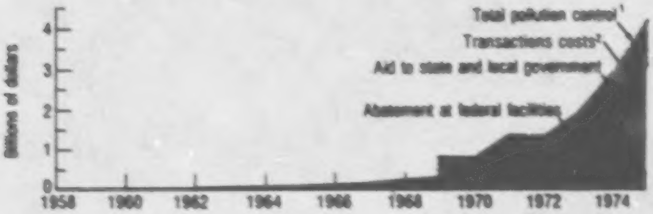
[3] Business includes current account spending by government enterprises and all spending by homeowners. Current account by government enterprises was $1,198 million. Residential pollution abatement amounted to $936 million on capital account and $125 million on current account.

Source: U.S. Department of Commerce, "National Expenditures for Pollution Abatement and Control, 1972," *Survey of Current Business*, 55(2) (February 1975), p. 9.

Figure 9

Federal Expenditures for Pollution Control, Actual Fiscal Years 1958-74 and Estimated Fiscal Year 1975

(in billions of current dollars)



[1] The jump at 1969 in total pollution control expenditures occurs because the budget analyses were modified after that date to include more federal agencies.

[2] Primarily administration, research, enforcement, and monitoring.

Source: For 1958-1969 data, Office of Management and Budget, *Budget of the United States Government*, annual (Washington, D.C.: Government Printing Office, 1958-69), and unpublished Office of Management and Budget data; for 1969-75, Office of Management and Budget, *Special Budget Analyses, Budget of the U.S. Government*, annual (Washington, D.C.: Government Printing Office, 1970-75).

Table 8

Comparison of Automobile Retail Price Increase Estimates for Automobile Pollution Control

(In current dollars)

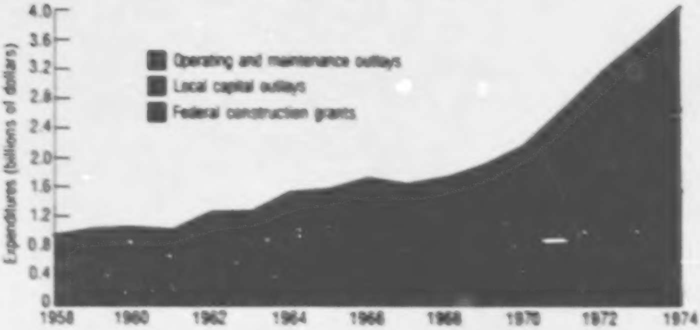
Model year	Environmental Protection Agency	National Academy of Sciences	Bureau of Labor Statistics	Industry
1968	5.40	6.65	16.00	—
1969	5.40	6.65	16.00	—
1970	35.00	39.38	21.50	—
1971	35.00	39.38	40.50	—
1972	35.00	39.38	47.50	—
1973	87.00	54.53	75.20	80.00
1974	87.00	54.53	76.60	80.00
1975	200.00	159.00	195.80	208.00

Sources: Environmental Protection Agency, *The Cost of Clean Air*, annual (Washington, D.C.: Government Printing Office, 1974); National Academy of Sciences, "Report by the Committee on Motor Vehicle Emission," prepared for the Environmental Protection Agency under contract no. 68-01-0402, February 1973; U.S. Department of Labor, Bureau of Labor Statistics, press releases, 1968-74; letter from J. J. Ricardo, President, Chrysler Corp., to Senator P. V. Domenici, May 24, 1975; letter from L. A. Iacocca, President, Ford Motor Co., to Senator P. V. Domenici, May 13, 1975; E. E. Estes, President, General Motors Corp., written testimony, Senate Committee on Public Works, Subcommittee on Environmental Pollution, 94th Cong., 1st sess., May 15, 1975, p. 13.

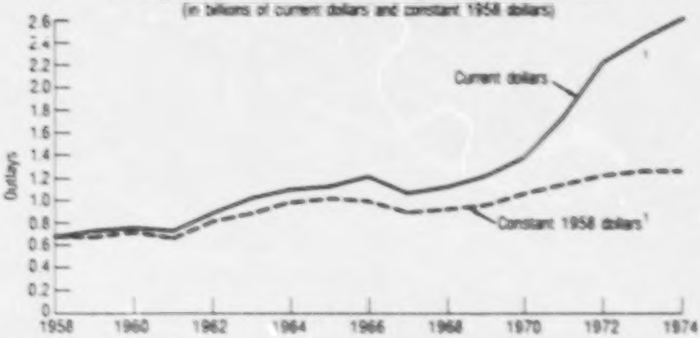
Figure 10

Total Government Expenditures for Sanitation, 1958-74

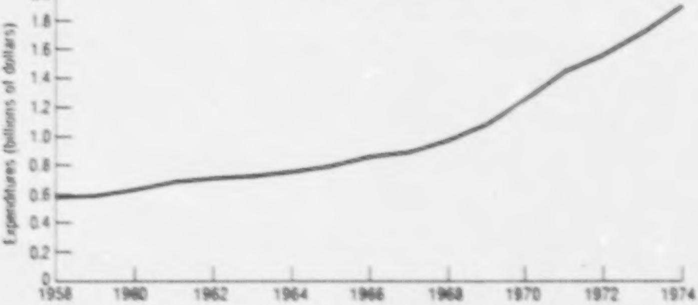
Sewage collection and treatment (in billions of current dollars)



Total government capital outlays for sewage collection and treatment (in billions of current dollars and constant 1958 dollars)



Local government expenditures on sanitation other than sewage (in billions of current dollars)



[1] EPA sewer and treatment plant cost indices were used to convert to constant dollars.

Source: U.S. Department of Commerce, Bureau of the Census, *Government Finances*, annual (Washington, D.C.: U.S. Government Printing Office, 1959-74); Office of Management and Budget, *Special Analyses: Budget of the United States Government* (Washington, D.C.: U.S. Government Printing Office, 1970-74).

expenditures, and the portion covered by federal assistance, have grown since 1958. The federal share was below 5 percent in 1958, grew to 10 percent through 1969, and then increased to 60 percent in 1974.[41] It will increase further with project grants under the 75 percent federal cost sharing of the 1972 Amendments to the Federal Water Pollution Control Act.

As the center section of Figure 10 indicates, inflation has taken a large portion of these increased expenditures. The cost of building treatment plants has increased even faster than most other costs. As a result, annual waste water treatment investments increased only 40 percent in real terms between 1967 and 1973 while increasing 128 percent in dollar terms.

Total expenditures for sanitation (excluding sewage) are shown in the bottom section of Figure 10. Primarily solid waste costs, they also include some expenditures for street cleaning and litter control. Local governments are currently spending about twice as much on waste water collection and treatment as on solid waste collection and disposal. However, because approximately two-thirds of residential and commercial solid waste is handled by private collectors, many of these costs do not enter the government accounts summarized above. Again, the real value of resources expended on sanitation (after adjusting for inflation) has increased much less rapidly than the apparent value.

There are no similar data for air pollution abatement. Such expenditures often appear in the budgets of the departments operating the facilities where the abatement is taking place and are therefore much harder to identify.

PUBLIC TRANSACTIONS COSTS

Although most funds that governments spend for pollution control go directly to abate pollution, significant amounts are also spent on transactions costs such as planning, monitoring, and enforcement. These expenditures, primarily those of federal, state and larger local governments are often hard to identify because they are not separated from direct abatement expenditures or because they appear in budgets of departments other than the ones responsible for pollution control. The private sector may also spend considerable amounts in planning pollution abatement strategies, in filling out government forms, and for other purposes that should be included as transactions costs. To the extent that these costs are reported, however, they are lumped in with abatement costs and no differentiation is possible.

Estimates for the public sectors are possible because of recent improvements in the federal government's analysis of its environmental expenditures (see Appendix F) and because better state and local data are being provided to EPA as part of the state planning grants program. These are the two major sources used in preparing the estimates that follow.

Table 9 summarizes federal transactions expenditures for 1974, 1975, and 1976. The largest single transactions cost is for research related to pollution control, although these numbers may overstate transactions costs because some "primary" research (an activity whose primary purpose is pollution control and abatement) might better be allocated to abatement costs, and some secondary research (an activity which contributes to pollution control and abatement but which has some other primary purpose) may well be related more to basic scientific understanding than to abating pollution.[62]

From fiscal year 1974 through fiscal year 1976, approximately $2.9 billion, or 25 percent of all federal pollution control expenditures, is

Table 9

Distribution of Federal Outlays Between Transactions and Abatement Costs and Direct and Transfer Payments, Actual 1974 and Estimated 1975–76

(In millions of dollars)

	1974		1975		1976	
	Direct [1]	Transfer	Direct	Transfer	Direct	Transfer
Transactions outlays						
Grants program administrative costs	8.3	0	7.8	0	7.7	0
Planning grants		3.7		30.1		83.0
Manpower development	3.8	5.7	6.0	4.3	10.9	2.5
Standards and enforcement	303.7	0	368.4	0	416.5	0
Research, development, and demonstrations (primary)	267.9	22.5	368.3	28.1	437.8	37.5
(secondary)	101.5	22.6	161.4	23.5	182.6	25.7
Totals	685.2	54.5	911.9	86.0	1,055.5	148.7
	739.7		997.9		1,204.2	
Abatement outlays and other expenditures	379.3	1,855.2	553.8	2,660.8	676.4	2,661.3
	2,234.5		3,214.6		3,337.7	
Total outlays	1,064.5	1,909.7	1,465.7	2,746.8	1,731.9	2,810.0
	2,974.2		4,212.5		4,541.9	
Transactions costs as a percentage of total outlays	64%	3%	62%	3%	61%	5.2%
	25%		24%		26%	

[1] Direct outlays are expenditures by the federal government for purchase of goods and services. Transfer payments are outlays made to state and local governments for their use.

Source: Office of Management and Budget, *Special Budget Analyses Fiscal Year 1976*, Analysis Q, pp. 268–281 (Washington, D.C.: Government Printing Office, 1975); supporting data supplied by OMB.

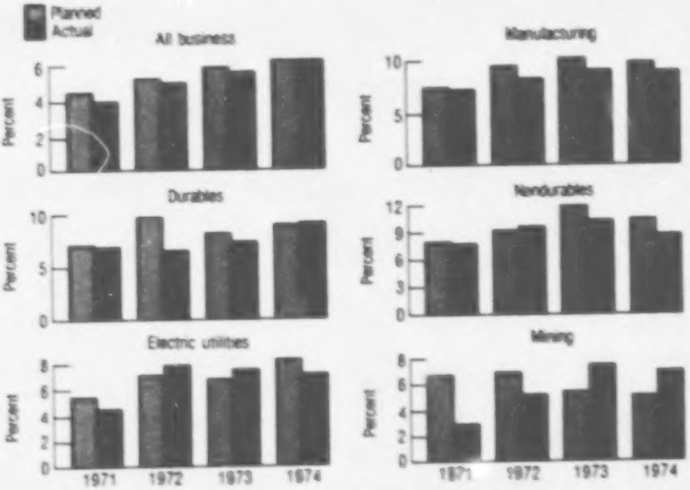
for items included under transactions costs. In contrast, total state and local transactions expenditures were estimated at approximately $150 million in 1972, over one-third of which was supplied by the federal government.[63]

COST PROJECTIONS

The McGraw-Hill surveys collect information not only about what industry is paying for pollution control but also about what it expects to pay in the following year. Overall, the projections for the 4 years 1971–74 have proved reasonably accurate, with some tendency toward overestimation of future expenditures (especially if actual costs are adjusted to take account of inflation between the 2 years). But in individual sectors many of the estimates are surprisingly inaccurate, as is shown in Figure 11. For manufacturing, projected expenditures were overestimated to a considerable degree. For mining and electric utilities, there were substantial underestimates in some years, overestimates in others. McGraw-Hill also asks businesses the total amount that they expect to invest to meet current environmental regulations. These estimates (which appear to be very rough) are generally below those made by EPA and CEQ which depend upon engineering cost analyses.

Figure 11

Planned and Actual Expenditures for Pollution Abatement as a Percentage of New Plant and Equipment Investments



Source: McGraw-Hill Publications Company, "McGraw-Hill Survey of Pollution Control Expenditures," annual (New York: 1972-75).

CEQ's estimate of incremental abatement costs for the 10 years 1974 through 1983 is given in Table 10. Incremental costs are those required to satisfy federal environmental legislation beyond what would have been spent in the absence of this legislation. Four types of costs are shown:

- "Investment costs"—the estimated expenditures by both public and private sectors on capital equipment for pollution abatement
- "Capital costs"— interest charges on pollution control investments and depreciation of the capital equipment
- "O&M costs"—costs of operating and maintaining the pollution abatement equipment
- "Annual costs"—the sum of the capital and the O&M costs. The last column in Table 10 shows the simple sum of annual costs for all 10 years.

The estimates are based primarily on data provided by the Environmental Protection Agency and other federal agencies.

To a great extent the cost estimates assume end-of-the-pipe treatment for air and water: this may overstate the potential cost because it ignores less costly production modifications that also satisy the law. The chapter appendix includes additional information on the methodology, assumptions, and data sources for these estimates.

Comparing the separate estimates with last year's, we see that industrial air pollution abatement costs have increased noticeably but mobile source costs have fallen (partially because of extensions in deadlines, partially because of lower unit cost estimates). Estimates for industrial water pollution control have increased substantially with the full inclusion of estimated costs associated with the 1983 best available technology standards, but projected municipal waste water expenditures are slightly lower as a result of revised estimates on the rate of federal funding (in constant dollars). The revised costs for noise regulations show a substantial drop as a result of new information provided by EPA. Air pollution investment costs are expected to reach a peak during the years 1975 to 1977, and water pollution investments are expected to rise steadily through the decade, reaching a peak in 1983.

Distribution by Sector

The consumer will directly pay $67.7 billion of the cumulative costs of pollution control for 1974 through 1983. This share goes for automobile pollution abatement and solid waste collection. However, approximately $6.7 billion of the mobile source costs that the consumer pays is for federal and state gasoline taxes. Government will spend $31.9 billion (or a net of $25.2 billion after subtracting taxes collected on the increased gasoline consumption), but of course these government costs are ultimately paid by the taxpayer. Electric utilities will pay $38.3 billion and other industries the remaining $79.8

billion. Most of these costs will be passed on to the consumer in the form of higher electricity and product prices. Ultimately people—as consumers and taxpayers—pay all the costs of cleaning up the environment.

These costs average out to approximately $47 per capita for 1974. For the median income family, pollution abatement costs will rise to about 2.5 percent of gross family income in 1983 before the ratio begins to decline again.

Distribution Between Investment and O&M Costs

In terms of real resource costs, CEQ estimates that $115.2 billion will be invested in capital equipment and $112.1 billion spent on operation and maintenance costs (after deducting taxes) over the 10 years. For many sectors O&M costs will become relatively more important over time (mobile source abatement is expected to be a significant exception). As noted earlier, the CEQ estimates of investment costs may be too high because of emphasis on end-of-the-pipe capital investments as opposed to less investment-intensive process changes. The Bureau of Economic Analysis surveys reported earlier in this chapter distinguished between end-of-the-pipe investments and production process modification and found that approximately one-fourth of investments are for production process changes.

MACROECONOMIC IMPACTS

The estimated incremental real resource abatement costs (investment plus O&M less taxes) amounted to approximately 1.1 percent of the Gross National Product in 1974. This proportion is expected to grow to approximately 1.5 percent in 1979; it will then level off through 1983 as investment costs and GNP grow at similar rates and will then decrease.

Private pollution control investments (excluding mobile sources) are estimated at less than 2.5 percent of gross private domestic investment and 4.5 percent of total business investment in plant and equipment in 1975. These ratios are expected to increase slightly through 1979, when they will fall temporarily before rising to a second peak in 1983.

Impacts on Employment

The major economic issue in 1975 has been unemployment and how to reduce it. Environmental programs are frequently accused of being a major cause of unemployment. However, all the analyses seem to indicate that they have on net probably increased, not decreased, the number of available jobs. This is so because of expenditures stimulated by the air and water pollution control deadlines and by the municipal grants program.[44] Construction of sewers and sewage treatment plants, for instance, is relatively labor intensive. Each

Table 10

Estimated Incremental Pollution Control Expenditures, 1974–83 [1]

(In billions of 1974 dollars)

Pollutant/medium	1974			1983			Cumulative—1974–83			
	O&M [2]	Capital costs [3]	Total annual costs [4]	O&M [2]	Capital costs [3]	Total annual costs [4]	Capital invest-ment	O&M [2]	Capital costs [3]	Total annual costs [4]
Air pollution										
Public	0.1	0.1	0.2	0.6	0.2	0.8	1.9	4.2	1.8	6.0
Private										
Mobile	4.1	1.0	5.1	2.7	6.1	8.8	35.2	32.7	37.5	70.2
Industrial	0.6	0.5	1.1	2.9	2.5	5.4	13.6	20.0	17.5	37.5
Utilities	0.4	0.3	0.7	3.0	2.2	5.2	13.4	17.2	12.8	30.0
Total	**5.2**	**1.9**	**7.1**	**9.2**	**11.0**	**20.2**	**64.1**	**74.1**	**69.6**	**143.7**
Water pollution										
Public										
Federal	0.2	<0.05	0.2	0.2	<0.05	0.2	2.0	2.0	0.3	2.3
State and local	0.5	0.7	1.2	1.9	1.6	3.5	13.0	10.5	9.9	20.4
Private										
Industrial	0.6	0.4	1.0	5.0	3.3	8.3	30.5	22.8	14.5	37.3
Utilities	0.1	0.1	0.2	0.7	0.6	1.3	3.3	4.4	3.7	8.1
Total	**1.4**	**1.2**	**2.6**	**7.8**	**5.5**	**13.3**	**48.8**	**39.7**	**28.4**	**68.1**
Radiation										
Nuclear powerplants	NA	NA	NA	<0.02	<0.03	<0.05	0.1	0.1	0.1	0.2
Solid waste										
Public	0.1	0.1	0.2	0.3	0.1	0.4	1.1	2.4	0.8	3.2
Private	0.1	<0.05	0.1	0.6	<0.05	0.6	<0.05	2.5	<0.05	2.5
Total	**0.2**	**0.1**	**0.3**	**0.9**	**0.1**	**1.0**	**1.1**	**4.9**	**0.8**	**5.7**
Land reclamation										
Surface mining [5]										
Noise	NA	NA	NA	NA	NA	NA	1.1	NA	NA	NA
Grand total	**6.8**	**3.2**	**10.0**	**17.9**	**16.6**	**34.5**	**115.2**	**118.8**	**98.9**	**217.7**

NA=Not available.

[1] Incremental costs are expenditures made pursuant to federal environmental legislation beyond those that would have been made in the absence of this legislation.

[2] Operating and maintenance costs.

[3] Interest and depreciation.

[4] O&M plus capital costs.

[5] Not included in this year's estimate.

Incremental pollution abatement costs are associated with converting open dumps (top) to sanitary landfills (center), but these in turn may later be used for other purposes (bottom).

billion dollars spent generates 20,000 to 25,000 jobs at the construction site, a similar number of jobs in manufacturing the equipment and materials required for the facilities, and after including the impact of the workers' consumption expenditures, up to 85,000 jobs in all.[45] Not only are workers needed to manufacture the pollution control equipment and construct the facilities, but over the longer term many will be needed to operate and maintain the equipment. In the same vein, a National Academy of Sciences study has pointed out the need for more trained mechanics to maintain automobile emissions control systems.[46] Another NAS committee is currently studying the total manpower requirements of our pollution control programs, with a report expected in early 1976.

Macroeconomic analyses (based on the CEQ 1974 cost estimates) sponsored by CEQ and EPA show that employment is somewhat higher with pollution control expenditures than without them but that it may drop below this "baseline" level in the latter half of the decade.[47] By the end of the decade there should be no significant difference in the unemployment rate between what is expected with or without pollution control problems.

These macroeconomic analyses do not take account of the plant closings caused by environmental regulations. However, EPA monitors such threatened and actual closings with its "Economic Dislocation Early Warning System." Table 11 summarizes the reports received by EPA from January 1971 through June 1974 on plants which purportedly closed because of environmental regulations. A total of 75 plants affecting over 13,600 employees (0.015 percent of the labor force) was reported to be affected.

The Department of Commerce has also surveyed plant closings associated with pollution control requirements.[48] Approximately 0.5 percent of all companies surveyed reported that a plant or a facility within a plant had been closed in 1974 for reasons at least partially related to pollution control requirements. The DOC survey, however, provided no information about employment effects.

The number of jobs lost to the economy because of these closings is less than the number employed in the plants which actually close. Their production will usually be shifted to other plants (often within the same compay) and more jobs are created there. There is probably some net job loss because the plants which increase production are likely to be more efficient than those which close. It is their relative inefficiency—they are usually older, smaller facilities that are only marginally profitable even without the required environmental controls—that leads to decisions to close these plants rather than modernize them. In the Department of Commerce survey, age and obsolescence of the facility, increasing operating costs, and declining sales were also reported as contributing factors in 78 percent of the plant closings. In many instances they would soon be closed anyway, and environmental regulations only accelerate an otherwise inevitable process.

Table 11

Plant Closings Allegedly Due in Part to Pollution Abatement Costs, by Industry, January 1971–June 1975

Industry	Plants	Employees	
		Number	Percentage of industry's labor force
Manufacturing			
Durables			
Lumber and wood products	4	510	0.091
Stone, clay, and glass	6	401	0.066
Primary metals	16	3,425	0.301
Fabricated metal products	5	810	0.062
Nondurables			
Food products	11	610	0.037
Paper and allied products	10	3,227	0.510
Chemical and allied products	6	2,115	0.210
Textile mills	4	833	0.092
Leather and leather products	1	130	0.050
Painting and publishing	2	591	0.055
Rubber and miscellaneous plastic products	1	188	0.032
Petroleum refining	1	350	0.182
Mining	3	260	0.037
Services	3	233	0.005

Source: Environmental Protection Agency, Office of the Administrator, 1975 second quarter report of the Economic Dislocation Early Warning System; U.S. Department of Labor, Bureau of Labor Statistics, "The Employment Situation: July 1975," *U.S. Department of Labor News*, August 1, 1975.

The problem of plant closings should not be understated, however. There is some geographical concentration of the plants which have closed (Figure 12), and many are located in older, industrial towns already suffering relatively high unemployment rates.* Their closures can seriously hurt the local economy and people who may have difficulty finding other jobs. Recognizing these problems, EPA monitors threatened plant closings through its Economic Dislocation Early Warning System and periodically advises the Department of Labor of its findings.

Impacts on Economic Growth

Another concern about environmental programs is that the investments required may displace investments to expand or modernize production capacity. If such substitutions were widespread, labor productivity would fall because firms would be using older, less productive equipment, and the lower growth in productivity would slow down the nation's economic growth.

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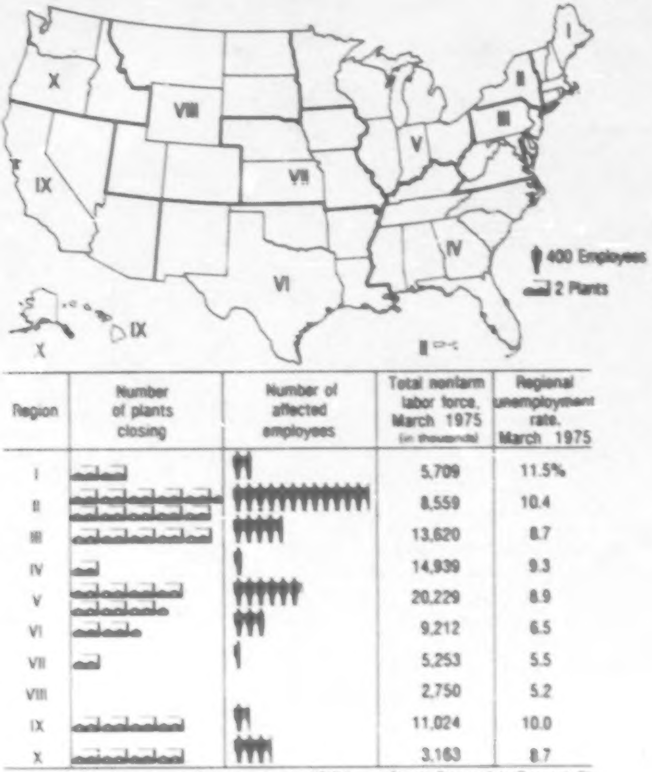
*The Department of Commerce survey found the highest concentration of closings in the Southeast (25 percent), Great Lakes states (19 percent), and Plains (18 percent). (See note 48.)

Figure 12

Plant Closings Allegedly Due in Part to Pollution Abatement Costs, by Location



Region	Number of plants closing	Number of affected employees	Total nonfarm labor force, March 1975 (in thousands)	Regional unemployment rate, March 1975
I			5,709	11.5%
II			8,559	10.4
III			13,620	8.7
IV			14,939	9.3
V			20,229	8.9
VI			9,212	6.5
VII			5,253	5.5
VIII			2,750	5.2
IX			11,024	10.0
X			3,163	8.7

Source: Environmental Protection Agency, 1975 Second Quarter Report of the Economic Dislocation Early Warning System; Department of Labor, Manpower Administration, "Labor Force Data for States and Major Labor Areas, May 1975."

But such effects will probably be slight on a macro level. The projected investment for environmental purposes by all the U.S. industries is not likely to exceed 6 percent of their total plant and equipment expenditures in any one year and should average about 4.6 percent over the 10-year period. Furthermore, in some instances, pollution control requirements may stimulate investment in more modern production processes and thereby raise labor productivity.[49]

Pollution control expenditures, of course, will place increased demands on the capital market and as a result will probably displace some private investment. This capital market problem seriously concerns many observers. During the next decade the United States will be experiencing relatively high capital demands for a number of reasons--pollution control, capacity expansion, and energy developments—and as a result interest rates will probably remain high.[50] Specific industries (the electric utilities industry is a prime example) may find themselves facing serious capital shortages.[51] However, a recent study by the Brookings Institution concludes that "with normal growth and without unusual sacrifices the economy will be able to meet the capital demands that can reasonably be projected for the remainder of the decade." [52] This optimism should be tempered by their concurrent conclusion that private savings will be less than the demand for private investment, and therefore the government will have to exercise very careful fiscal management to avoid either a serious capital shortage or renewed high inflation rates.

CEQ/EPA-sponsored analyses also indicate that the demands for pollution control investments will not seriously disrupt capital markets or displace significant amounts of investment for capital expansion, although they do suggest that the resulting higher interest rates may adversely affect the housing market.[53] In light of all these findings, pollution control expenditures are not expected to impede substantially industry's plans to expand or modernize or to affect labor productivity adversely.

If the impact of environmental expenditures on plant and equipment investment and therefore on productivity is minor, the rate of growth of the "full employment GNP" will be affected very little. According to CEQ/EPA-sponsored macroeconomic analyses, pollution control expenditures are currently stimulating the economy so that GNP is higher than it otherwise would have been. As the rate of investment declines, the slightly higher prices resulting from pollution control expenditures will have a minor depressing effect on the economy, causing the real GNP to dip below the expected level. After a few years, this depressing effect is expected to disappear, so that the GNP will be at the same level that it would have been without environmental improvement programs. The projected GNP levels with (using the 1974 CEQ cost estimates) and without pollution control expenditures are summarized in Figure 13.

Impacts on Inflation

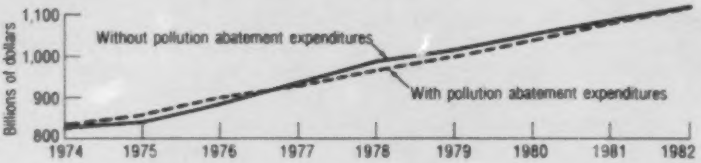
Next to unemployment, inflation was still the biggest economic worry in 1975. The impact of pollution control expenditures on inflation has been estimated by several independent analyses using macroeconomic computer models.[54] These show extra inflation rates of 0.3 to 0.5 percent per year resulting from spending for pollution control. Inflation data from the CEQ/EPA-sponsored analyses are shown in Figure 14.

It should be recognized that these analyses all assume that the economy is working smoothly and that there is sufficient production capacity and capital availability to satisfy all demands for investment, raw materials, and intermediate goods. Where "structural bottle-

Figure 13

Projected Economic Growth, 1974-82

(in real GNP, 1958 dollars)



Source: Chase Econometrics, Inc., "The Macroeconomic Impacts of Federal Pollution Control Programs," prepared for the Council on Environmental Quality and Environmental Protection Agency under contract No. EQ5AC002 (Springfield, Va.: National Technical Information Service, 1975), PB–240 979.

necks" exist, reducing supplies of these items below what they would be in a smoothly functioning economy, the analyses may understate the rate of inflation and the degree of economic disruption. To the extent that environmental programs contribute to these bottlenecks, their adverse impact is similarly understated.

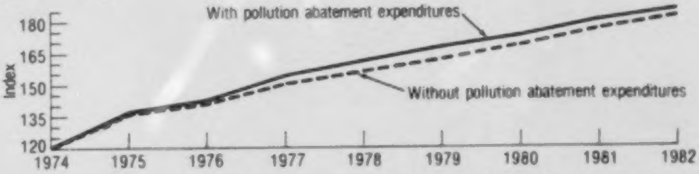
Impacts on Government Finances

Major government expenditures for federal environmental programs were summarized earlier. Figure 15 gives additional information on their budget impacts. The lefthand graph shows rapidly increasing expenditures during the 1970's for all elements in the federal budget allocated to "national resources, environment, and energy." As a percentage of total federal nondefense expenditures, however, the increase is much less dramatic (see the graph top right). Expenditures on "pollution control and abatement," which increased more than tenfold in dollar terms between 1969 and 1975, increased only half that much in terms of their proportion of the federal nondefense budget. The lower right figure indicates how rapidly the construction grants program has affected the flow of federal assistance to state and local governments.

Figure 14

Projected Wholesale Price Index, 1974-82

(1973=100)

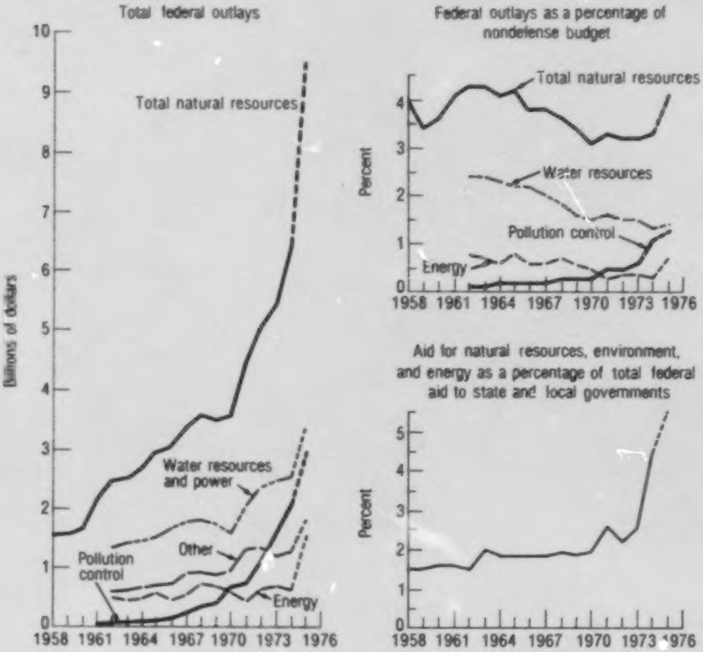


Source: Chase Econometrics, Inc., "The Macroeconomic Impacts of Federal Pollution Control Programs," prepared for the Council on Environmental Quality and the Environmental Protection Agency under contract No. EQ5AC002 (Springfield, Va.: National Technical Information Service, 1975), PB–240 979.

Figure 15

Federal Outlays for Natural Resources, Environment, and Energy, Actual Fiscal Years 1958-74 and Estimated Fiscal Year 1975[1]

(in billions of current dollars)



[1] Data are somewhat lower than the equivalent figures in *Special Analyses: Budget of the U.S. Government* and presented, e.g., in Figure 9 for 1969-76 because that source includes outlays of all federal agencies.

Source: Based on Office of Management and Budget data.

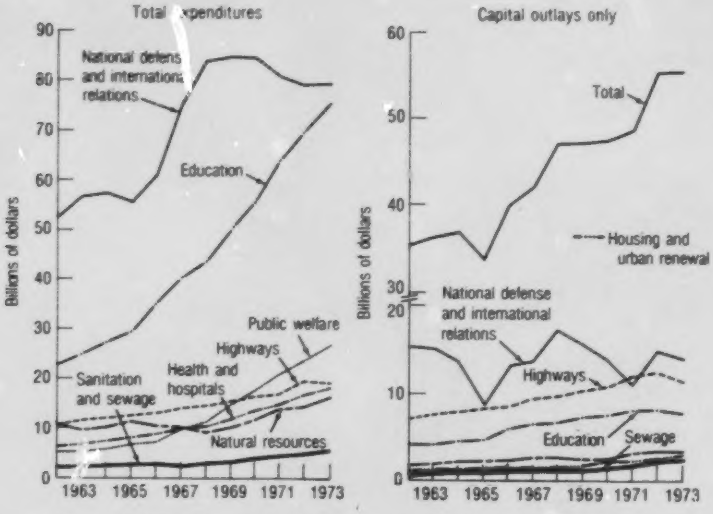
Local government net expenditures are expected to be lower than they would have been without the federal legislation because many of the investments for municipal sewage collection and treatment works would have been made even in the absence of a federal program, and under the existing program the federal government pays up to 75 percent of these investments. Many of these costs will also be paid for at the local level by user charges rather than by general revenues. The trends in sanitation and sewage expenditures compared to other government programs are indicated in Figure 16.

Some aspects of the pollution abatement program may indirectly have an adverse impact upon local government finances. While the municipal grants program has probably reduced local government capital expenditures below what they would otherwise have been, the

Figure 16

Government Expenditures on Sanitation Compared to Selected Government Programs, Fiscal Years 1962-73

(in billions of current dollars)



Source: Department of Commerce, Bureau of the Census, *Government Finances*, annual (Washington, D.C.: Government Printing Office, 1959-74); Office of Management and Budget, *Special Analyses: Budget of the United States Government* (Washington, D.C.: Government Printing Office, 1970-76).

use of industrial revenue bonds for industrial pollution abatement investments has placed a strain on the tax-free bond market, pushing up interest rates for all municipal bonds. At present, industrial revenue bonds are being issued at a rate exceeding $2 billion annually (which is equivalent to over 40 percent of total private pollution control investment), and the rate is projected to increase to over $5 billion by the end of the decade.[55] This increased issue of tax-exempt bonds, because it increases the demand for loans in the municipal bond market, can be expected to raise interest rates on all municipal bonds—perhaps by as much as one-fourth percentage point. The combination of lost tax revenues (to all levels of government) and increased borrowing costs has been estimated to be substantially above the cost savings to the firms issuing the bonds.[56] As a result, there is increased concern that use of industrial revenue bonds should be restricted.[57]

Impacts on Foreign Trade

Since our stringent pollution control program began, there has been some concern that it would have an ill effect on foreign trade—either because U.S. goods would be less competitive in the world market or because U.S. firms would locate new plants abroad. A number of studies on this issue conducted by the Department of Commerce, other federal agencies, and private concerns have not found any significant adverse impact.[39] Some U.S. exports are slightly more costly and some imports are more competitive, but the total effect is small. The reasons are these: U.S. goods are not expected to go up much in price as a result of environmental requirements; some commodities that are increasing in price do not face strong competition from imports because of weight, bulk, or U.S. quality requirements; and many competing countries are also enacting stringent environmental regulations that will reduce any comparative advantage that their industries might have.

Impacts on Specific Industries

As the foregoing analyses indicate, environmental programs are not likely to have a substantial impact on the economy as a whole. The effects that they do exert are not spread evenly across all sectors.

Some industries pollute much more than others and therefore have to do more to abate pollution. Figure 17 summarizes the BEA findings about relative investments for pollution control among various industries. The nonferrous, paper, iron and steel, and stone, clay, and glass industries all put more than 10 percent of their total plant and equipment expenditures into pollution control for the 2 years 1973 and 1974, compared to an average of 7.8 percent for all manufacturing and 4.8 percent for all business. The petroleum, chemicals, and electric utility sectors also face relatively heavy pollution control expenditures. Seven industrial groups (the first of seven listed in Figure 17) accounted for 75 percent of all private pollution control investments in 1973 and 1974, and are all expected to continue relatively heavy pollution control expenditures over the next decade.

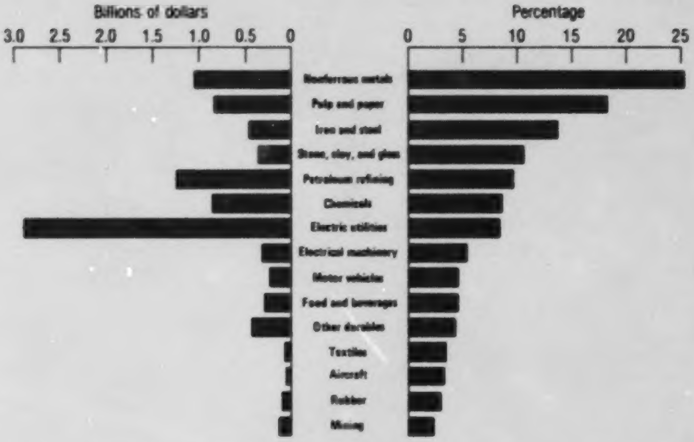
These seven share some important characteristics. They are all "basic industries," which means that their price and supply problems affect the whole economy. Some are capital intensive and therefore are affected by the tight capital markets projected for the coming decade. They are generally energy intensive, accounting for three-quarters of all energy consumed by all manufacturing and nearly one-fifth of total U.S. energy consumption. For them energy is a particularly significant cost element. These industries have an energy intensity five to eleven times that of all other manufacturing (Figure 18). They face serious cost problems because of high energy prices in addition to the costs added by environmental regulations.

In short, these industries may be facing several problems simultaneously. Their direct pollution control costs as a percentage of total value of shipments (Figure 19) appear within reason; so do their capital investments as a whole (see the BEA data). Nevertheless, their problems deserve close analysis. CEQ, EPA, and the National Commission on Water Quality are completing such studies.

Figure 17

BEA Estimates of Pollution Abatement Investments as a Percentage of Total Plant and Equipment Expenditures for Selected Industries, 1973 plus 1974

(in billions of current dollars)



Source: Based on U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, Vol. 55, No. 7, July 1975, p. 16.

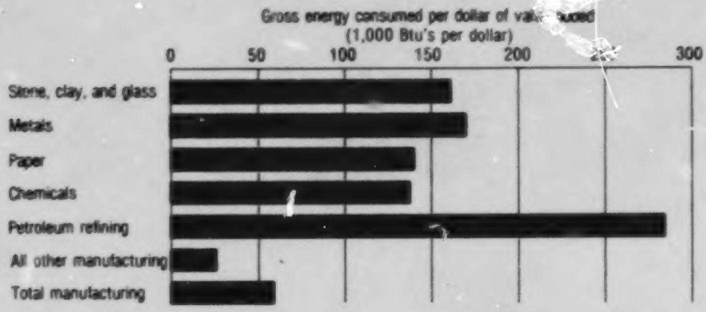
BALANCING COSTS AND MAKING DECISIONS—ENERGY FACILITY SITING

It is one thing to espouse general concepts about decisionmaking and present aggregate data about costs, and it is quite another to use these general rules and determine costs for particular decisions. The essential concepts have been known for years but rarely applied in any rigorous fashion. In this concluding section of the chapter, we attempt to illustrate how they could be applied to an important decision that the nation is facing today. The subject is energy development, particularly the question of where new energy facilities should be sited. The purpose is to demonstrate how we can use the limited and imperfect information that we do have about these costs to make better decisions about development.

This section omits many of the important questions that enter into energy facility siting decisions. For example, a full analysis should begin with the question of how much energy is needed and what the tradeoffs are between expanding energy production and conserving energy use. A second question is what energy sources—nuclear, coal, solar, geothermal—should be developed.

Figure 18

Energy Intensity of Selected Industries, 1967



Source: Based on the Conference Board, *Energy Consumption in Manufacturing* (Cambridge, Mass.: Ballinger Publishing Co., 1974), p. 21.

These questions deserve careful analysis similar to the one presented here, balancing off the different costs involved. This analysis assumes that both questions have been satisfactorily answered, that we have decided on how much energy we need and what energy resource we are going to exploit. Here we concentrate on the question of energy facility siting.

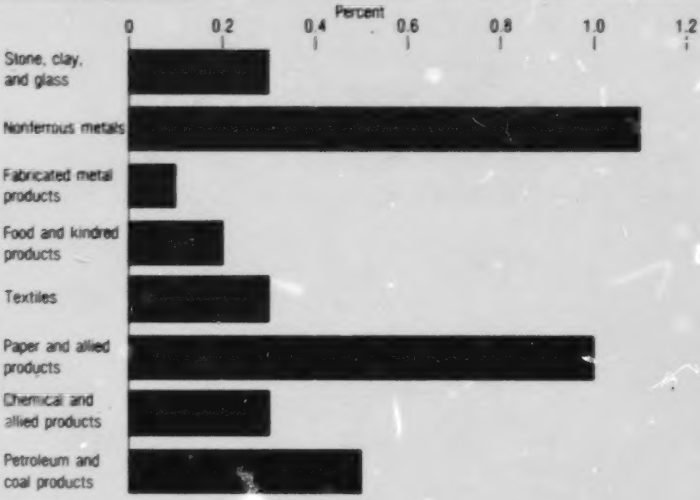
People have been siting energy facilities since they first discovered how to use fire. Until recently, however, the question of where facilities should be sited was a matter of little public concern. For technical reasons the energy conversion facility—the fireplace or the electrical generating plant—was located near the point of energy use. Energy extraction facilities—the wood lot, coal mine, oil well—were seen primarily as a source of income. Neither conversion nor extraction facilities were perceived as creating serious environmental costs.

All this is very much changed. Today new large-scale energy facilities are often built far from where the energy will be used, and there is growing awareness of the siginficant impacts that they can create. Energy development and use are very much a public issue.

The focus in this section is on western energy. As the nation pursues its goal of reducing dependence on imported oil, the extensive energy sources west of the Mississippi will be subject to increasing development pressure. The kinds of resources to be developed, where the development will occur, how and where the energy will be processed, converted, and transported—all these will be analyzed and debated many times over in corporate board rooms, in government, and in public. Some of the development has already begun, and a number of studies have been undertaken to assist in these development decisions.[59]

Figure 19

Direct Abatement Costs as a Percentage of Value of Shipments for Selected Industries, 1974



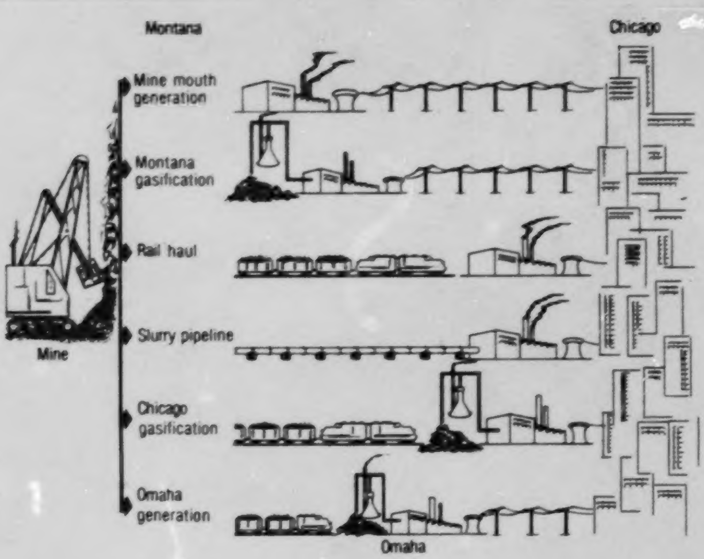
Source: Based on U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, Vol. 55, July 1975, p. S–5, and CEQ cost estimates.

This section concentrates on one small part of this issue. It assumes that a decision has been made to develop Montana coal in order to supply Chicago with electricity.

The questions are where and how the coal should be converted into electricity. Six possibilities are shown in Figure 20. In the first option ("mine mouth") the electricity is generated directly from coal in Montana and is then transmitted to Chicago. In the second option ("Montana gasification"), the electricity is also generated in Montana but the coal is converted first to low Btu gas and then to electricity. The third, fourth, and fifth options ("rail haul," "slurry pipeline," and "Chicago gasification") involve generating the electricity in Chicago. In the rail haul option the coal is shipped to Chicago by rail and converted directly to electricity. In the slurry pipeline option the coal is pulverized and mixed with water in Montana and pumped in a slurry pipeline to Chicago, where it is again used directly to generate electricity. In the Chicago gasification option, the coal is shipped by rail to Chicago but is converted there into low Btu gas which is used for generating the electricity locally. The sixth option ("Omaha generation") involves transporting the coal by rail to an intermediate point like Omaha, which has a plentiful supply of water, where it is converted to low Btu gas and then to electricity which is transmitted to Chicago.

Figure 20

Options for Supplying Electricity to Chicago from Montana Coal



All the following comparisons are made on the basis of 1 trillion Btu's per day (equivalent to 293 million kwh per day) of electricity delivered to Chicago. This amount of energy, which equals about 0.5 percent of Chicago's present electricity use, would require as many as 20 separate generating stations and (where applicable) 2–4 gasification plants. The scenarios differ primarily in amount of air pollution and other environmental damages, location of these damages, and cost of the electricity delivered to Chicago. The analysis assumes that each polluting source has adopted the best practicable abatement technology; any reductions in environmental damages come not from pollution control equipment such as scrubbers but from changes in the type and location of the production process.

This analysis is based on the western energy study which the Council, in association with other federal agencies, is sponsoring. The study is discussed in more detail in Chapter 7.

ENVIRONMENTAL EFFECTS

Some environmental effects of the six alternative scenarios are summarized in Table 12, which indicates both magnitude and location of an effect. Scenarios which involve low Btu coal gasification usually generate less air pollution than those involving coal-fired

Table 12

Environmental Effects of Energy Supply Options[1]

	Air emissions, in thousands of pounds/day			Solid waste, in thousands of tons/day[2]	Land use, in thousands of acres[3]	Water required, in millions of gallons/day	Occupational health, in thousands of man-days lost/year	Primary product efficiency (in percent)
	Particulates	SO_2	HC					
Mine mouth								
Surface coal mine (Montana)	55	0	0	0	5	0	3	100
Coal-fired powerplant (mine mouth)	16	3,244	37	10	13	128	5	37
Long distance transmission (Chicago)	0	0	0	0	161	0	NA	92
Total for scenario	216	3,245	38	10	179	128	NA	34
Montana gasification								
Surface coal mine (Montana)	73	1	2	0	7	0	4	100
Low Btu gasification (mine mouth)	0	41	4	16	9	22	22	76
Low Btu gas powerplant (mine mouth)	44	269	3	0	5	128	5	37
Long distance transmission to Chicago	0	0	0	0	161	0	NA	92
Total for scenario	117	312	9	16	182	150	NA	26
Rail haul								
Surface coal mine (Montana)	51	1	1	0	4	0	3	100
Rail to Chicago	40	91	44	1	36	0	22	99
Coal-fired powerplant (Chicago)	147	2,976	34	9	10	117	5	37
Total for scenario	238	3,068	80	10	50	117	30	37
Slurry pipeline								
Surface coal mine (Montana)	52	1	1	0	5	0	3	100
Slurry pipeline to Chicago	0	0	0	0	28	32	NA	98

Coal-fired powerplant (Chicago)	147	2,976	34	9	10	117	5	37
Total for scenario	199	2,977	36	9	42	149	NA	36
Chicago gasification								
Surface coal mine (Montana)	67	1	2	0	6	0	4	100
Rail to Chicago	52	120	59	2	47	0	29	99
Low Btu gasification (Chicago)	0	38	4	14	9	20	20	76
Low Btu gas powerplant (Chicago)	40	247	3	0	4	117	5	37
Total for scenario	160	406	67	17	67	137	58	28
Omaha generation								
Surface coal mine (Montana)	70	1	1	0	6	0	4	100
Rail to Omaha	27	63	31	2	25	0	30	99
Low Btu gasification (Omaha)	0	39	4	15	9	21	21	76
Low Btu gas powerplant (Omaha)	42	257	3	0	2	122	5	37
Long distance transmission to Chicago	0	0	0	0	77	0	NA	96
Total for scenario	140	360	39	17	119	143	NA	27

NA—Not available.

[1] Totals may not add because of rounding.

[2] The solid wastes associated with rail haul result from coal dust blown off the rail cars.

[3] Includes all the land in the transmission right-of-way; only a portion of the right-of-way land for the slurry pipeline because the land may be used for other purposes when the pipeline is buried; and the portion of railroad right-of-way equal to the portion of the total railroad capacity that would be taken up by coal trains.

Source: Radian Corporation, *A Western Regional Energy Development Study: Primary Environmental Impacts*, Vol. 1, prepared for the Council on Environmental Quality and the Federal Energy Administration under contract no. EQ4AC037 (Springfield, Va.: National Technical Information Service, 1975).

powerplants. The difference is most noticeable for sulphur oxides; gasification produces only about 10 percent as much as burning coal. Converting the coal to gas is thus a very effective way of abating air pollution.

The gasification plants create 50 percent more solid wastes than the scenarios involving direct burning of coal, they use somewhat more land and about 20 percent more water, and they involve something like twice as many man-days lost because of injuries. A tradeoff has to be made between these environmental effects and air pollution.

The different methods of transporting or transmitting the energy also create varying environmental effects. Some of these effects are listed in Table 12. Hauling coal by rail generates air pollution and solid wastes, whereas transporting it by slurry pipeline or transmitting electricity does not. The slurry pipeline requires water, and the high voltage transmission of electricity consumes four to six times as much land as the other transportation methods and creates aesthetic problems.

Transmitting electricity also creates indirect environmental effects. Transporting coal by rail or slurry pipeline is relatively efficient—the energy consumed in transportation is only 1 or 2 percent of the amount of energy transported. But 8 to 9 percent of the energy is lost in transmitting electricity from Montana to Chicago, even with the relatively efficient high voltage direct current transmission assumed here. This loss means that 9 percent more electricity will have to be generated in Montana in order to deliver the same amount of energy to Chicago, and at the generating place there will be 9 percent more air pollution, solid waste, water consumption, and so on. Transmitting electricity indirectly creates air pollution and other environmental damages, even though the transportation system itself is clean.

Gasification also produces indirect pollution. Because gasification is about 76 percent efficient, it requires that more coal be mined and hauled—with the associated environmental effects. The Montana gasification scenario is the least efficient of the six, requires the most coal to be mined, and therefore has the greatest environmental impact at the mine site.

Location as well as magnitude of these effects vary among the different scenarios. The location of impacts depends mostly on where generation or gasification takes place. Air pollution, solid wastes (excluding mining wastes), and water use are all concentrated in the West with the mine mouth and Montana gasification scenarios; in Chicago with the rail haul, slurry pipeline, and Chicago gasification scenarios; and in Omaha with the Omaha generation scenario. However, these last four scenarios also have environmental effects in Montana, whereas the first two have little environmental effect outside Montana and adjoining states except for the problem of transmission towers.

DAMAGE COSTS

To determine the damage costs of these environmental effects, we must first assess the impacts of the pollutants on ambient environmental quality. Table 13 indicates how air quality would be affected by the emissions from the various energy conversion facilities included in the scenarios. This table gives short-term and annual average pollution concentrations near the conversion facility. The estimates do not include background levels, and they assume that the different facilities are far enough apart that pollution from one does not affect pollution levels at another. To give an indication of the relative seriousness of these pollution levels, Table 13 also shows the ratio of these pollution levels to federal ambient air standards.

Table 13

Ambient Air Pollution Effects of Western Energy Options [1]

Option	Facility	SO_x			Particulates	
		3-hour	24-hour	Annual	24-hour	Annual
Mine mouth	Powerplants	265	40.2 (0.11)	2.07	2.0 (0.008)	0.10
Montana gasification	Gasification plants	155	33.8 (0.09)	6.29	0.01 (0.00004)	0.001
	Powerplants	21.[illegible]	3.3 (0.009)	0.17	2.1 (0.008)	0.03
Rail haul and slurry pipeline	Powerplants	265	40.2 (0.11)	1.43	2.0 (0.008)	0.07
Chicago gasification	Gasification plants	155	33.8 (0.09)	2.59	0.01 (0.00004)	0
	Powerplants	21.9	3.3 (0.009)	0.12	2.1 (0.008)	0.02
Omaha generation	Gasification plants	[illegible]55	33.8 (0.09)	2.87	0.01 (0.00004)	0
	Powerplants	21.9	3.3 (0.009)	0.14	2.1 (0.008)	0.02

[1] The expected maximum average pollution concentration in vicinity of facility ignores background pollution levels and assumes that pollution from one facility does not affect pollution levels near another. The numbers in parentheses show ratio of ambient pollution levels to primary air quality standards.

Source: Radian Corporation, *A Western Regional Energy Development Study: Primary Environmental Impacts*, Vol. 1, prepared for the Council on Environmental Quality and the Federal Energy Administration under contract no. EQ4AC037 (Springfield, Va.: National Technical Information Service, 1975).

By itself no facility will generate enough air pollution to violate the federal primary or even secondary air quality standards. But each of them will be adding to the background air quality levels. These levels are substantially worse in Chicago than in the West. For categories of damage costs for which the damage function slopes upward—for example, health, vegetation, and materials damages—the added pollution will impose higher costs per person exposed in Chicago than it will in Omaha or Montana. With its higher population, Chicago would suffer substantially higher damage costs for most of these categories than either of the other two localities. Of the pollutants identified, sulfur oxides are thought to be most serious in creating these types of damage. Therefore sulfur oxides must be considered the most serious air pollutant in identifying issues concerned with siting facilities in urban areas.

Total particulates may be the most serious problem in the West because they cloud the sky and limit the view (see Figure 2). One tradeoff then is between higher health, materials, and vegetation damage costs in Chicago and the aesthetic costs of degrading Montana's sky.

Conversion and transportation facilities also have aesthetic impacts which might well be greater in Montana, where they would stand out in a relatively undeveloped landscape than they would near Chicago or Omaha.

Water use too is a more serious consideration in the West where water is scarce and precious than it is in Chicago or Omaha. This factor affects the viability of the slurry pipeline which uses western water to carry the coal to Chicago. The water is not lost (based on the assumption that it is used for cooling at the powerplant), but in the West water is much more valuable than in Chicago. It is assumed that most western energy developments will get water from very deep ground water aquifers which are largely untapped. Although they seem to have sufficient capacity, in fact too little is known about the hydrology to predict their long-term adequacy. The question is whether without energy development the water would be used for another purpose. If so, it is more valuable than the cost of pumping it from the ground. We include it now only as an unquantified factor to be considered.

Solid wastes are a bigger problem near Chicago than in the West because disposal sites in Chicago are scarce. Suitable land for the energy facilities themselves is also scarce near Chicago.

The last direct effect which we considered is the energy efficiency of the system. The indirect impact of less efficient systems in creating additional air pollution has already been pointed out. But should less efficient systems be penalized beyond the cost of the wasted energy? There are reasons why the answer may be yes. If one option is substantially less energy efficient than the others, its effect will be to deplete limited energy resources more rapidly. The availability of adequate energy resources for future generations is a social concern that may not be adequately reflected in today's market decision. Similarly, the rail haul option consumes large amounts of oil as fuel for diesel engines. Market prices may not adequately reflect the cost of this oil in terms of the effect of increased oil imports on the U.S. balance of payments and national security.

As the discussion at the outset of this chapter emphasized, our ability to put damage costs into dollar terms is primitive, both because we lack sufficient data and because some damage costs are by their nature impossible to translate into dollars. Here we do not attempt to put a dollar value on these costs but approach them qualitatively.

Table 14 summarizes qualitatively the direct damage costs discussed above considering both magnitude and location. The table simply compares the scenarios in terms of designated effects.

Each of the first five scenarios entails the highest damage costs in some categories and the lowest in others. None of the scenarios seems to be clearly preferable by this ranking system. Considering only the direct damage costs, the final decision will involve a tradeoff between health damages in Chicago and aesthetic damages in the West. But there are many other costs which also have to be taken into account.

ABATEMENT COSTS

In the usual assessment, abatement costs are the costs of adding another scrubber to a smokestack or another module to a waste water treatment system. Our example is somewhat different. Abatement costs here are the change in production costs when one system is adopted rather than another. Gasifying the coal before it is converted to electricity makes substantially lower air pollution but at a

Table 14

Comparison of Environmental Damage Costs

	Mine mouth	Montana gasification	Rail haul	Slurry pipeline	Chicago gasification	Omaha generation
Air pollution damages						
Health		○M	●C	●C		
Materials		○M	●C	●C		
Aesthetic	●M		○C			
Other aesthetic	●M, I	●M, I		○C		
Western water use		●M	○M		○M	
Solid wastes	○M				●C	
Land use		●M		○C, I		
Energy wastage		●	○			
Occupational health	○M			○C	●I, C	

M=Montana
C=Chicago
I=Intermediate
●=Greatest damage effects
○=Least damage effects

Source: Based on Radian Corporation, *A Western Regional Energy Development Study: Primary Environmental Impacts,* Vol. 1, prepared for the Council on Environmental Quality and the Federal Energy Administration under contract no. EQ 4AC037 (Springfield, Va.: National Technical Information Service, 1975).

higher dollar cost. This higher cost is considered an air pollution abatement cost.

Some preliminary process cost estimates are provided in Table 15. Mining costs are a function only of how much coal has to be mined, which depends in turn on the overall efficiency of the system. Conversion costs depend upon whether coal is gasified or burned directly to generate electricity.

Transportation costs depend upon whether electricity or coal is being transported and what mode of transportation is used for the coal. Overall, the estimates indicate that generating electricity directly from coal at Chicago involves the least dollar cost and that it is always less expensive to generate the electricity directly from the coal than to gasify it first. It is also slightly cheaper to generate the electricity by either process in Chicago than farther West. A decision to favor any option other than the least cost option—in order to reduce health damages, for example—will increase costs, which the consumer pays in the form of higher electricity prices. These are the abatement costs.

INDIRECT COSTS

The discussion so far has dealt with direct costs associated with the different energy supply systems. Another relevant consideration is what are termed "secondary effects," but which in fact are not at all secondary. Energy supply developments may stimulate other in-

Table 15

Costs of Delivering 1 Million Btu's of Electrical Energy to Chicago

(1985 prices in 1975 dollars)

	Mine mouth	Montana gasification	Rail haul	Slurry pipeline	Chicago gasification	Omaha generation
Mining costs	1.73	2.13	1.62	1.62	2.00	2.07
Conversion costs						
Coal to gas to electricity		3.90			3.65	3.78
Coal to electricity	2.37		2.22	2.22		
Transportation and transmission costs						
Coal			1.65	1.70	2.03	1.00
Electricity	1.68	1.68				.88
Total costs per million Btu's	5.78	7.71	5.49	5.54	7.68	7.73

Source: Stanford Research Institute, "A Western Regional Energy Development Study: Economics," in preparation for the Council on Environmental Quality, Environmental Protection Agency, Energy Research and Development Administration, Department of the Interior, and National Science Foundation under contract nos. EQ5AC007 and EQ5AC008.

dustries to locate near them. For example, coal gasification facilities may attract chemical plants which use the byproducts of the gasification plant as raw materials. Such induced development will generate additional pollution and use additional water.

And workers will be needed, both for the energy supply facilities and for other industries attracted to the development. A gasification plant requires perhaps 10 times as many workers as an electrical generation plant. The increased population may place stresses on the economy, environment, natural resource base, and society where the people settle. New houses, roads, schools, hospitals, and other public services must be provided. Public expenditures for these purposes often severely stress the financial capacity of the communities involved, particularly because many investments must be made in advance of development so that they are ready when the new plants and people arrive. Small resident populations may at least initially bear these costs of serving an anticipated new population.

Often new firms provide high-paying jobs which are seen as an important benefit in regions with high unemployment and low wages. Not only will the companies generate more income, but their employees will spend the income on local goods and services. Thus, the original citizens may benefit both directly and indirectly from income generated by the new firms.

But it is quite likely that many workers at the facilities will come from outside the local area, especially during the construction phase. This immigration may have substantial social impacts—both good and bad—on the original population.

Strip mining is only the first step in converting western coal into electricity for Chicago.

The initial energy facility, associated industries, and population growth may also have significant environmental impacts. All forms of development will generate air pollution, water pollution, and noise. The impacts may be of great importance in places where people particularly prize the flavor of local life, and in fact may have given up higher incomes or other values in order to live there. In semirural western areas, for instance, secondary impacts may be a major development issue, and substantial planning will be needed to control them. In Chicago or Omaha, on the other hand, they would be less important because the population growth would be much less noticeable, being a small increment to the original population. The mine mouth and Montana gasification options would raise the biggest problems with secondary effects, the rail haul, slurry pipeline and Chicago gasification options probably the least.

SUMMARY AND FURTHER ISSUES

We have now dealt with most of the direct and indirect costs of the six alternatives that we chose as illustrative. None of the options is clearly superior to the others. Nor is there any way of sufficiently quantifying all the costs so that they can be added together and the simple sums compared. However, the number of tradeoffs can be reduced to make the decisions easier. The major tradeoffs would seem to be:

- *Where should the electricity be generated?* If it is generated in the West, it will cost up to 40 percent more and will involve relatively great aesthetic losses, depletion of scarce water resources, use of unspoiled land, lower energy efficiency, and greater secondary impacts. If it is generated in Chicago, it will involve health and materials damage costs and solid waste problems. Finding adequate sites may also be a problem. Omaha generation is in the middle of these two extremes.
- *Should low Btu gasification be employed?* Converting the coal to low Btu gas will reduce air pollution but increase water use, solid waste, land use, energy wastage, and occupational injuries. It is not clear whether the diminished health hazards from air pollution would be offset by increased occupational injuries. This possibility is more likely in the Montana gasification and Omaha generation options than when the gasification plants are located near Chicago. Gasification plants will also create additional secondary effects if located in rural areas.
- *How should coal be transported?* The slurry pipeline consumes more scarce western water, but hauling by rail consumes more petroleum. Whether additional considerations need be given to either of these concerns beyond their market price is not clear. Rail transportation, however, does involve many more injuries. There is little cost advantage or energy efficiency advantage between the two options.

These three questions and the trade offs involved in each appear to be the main ones that need an answer. But there are further considerations not yet mentioned. Our discussion has focused on the relative magnitude of total costs and has slighted what may be the more important question—who will pay them. Some of these costs will be reflected in the price of the electricity and thus will be paid by the final consumer in Chicago. But others will not. There is no ready answer to the question of how much people in Montana or Omaha should pay so that people in Chicago may have less expensive electricity. Nor is there any easy answer to the question of how much more people in Chicago should pay for electricity so that people elsewhere are not forced to pay uncompensated damage costs. There is no set of rules for answering these issues of regional equity, but clearly they are an important issue in making a final decision.

There are many unknowns involved in making decisions about energy development. To what extent is it possible to collect further information in order to reduce or eliminate these unknowns? The analyst must carefully consider the value of additional information and the cost of collecting it. For some parameters the value of additional information is slight, because any conceivable range of values would have minimal effect upon the decision. In some instances collecting additional information is too expensive both in resources and in time; then the reasonable approach is to test how the total cost and the likely decision would be affected for a range of plausible values for the unknowns. But there are some parameters which significantly affect the results of the analysis and for which additional data could be collected at reasonable cost. It is important to identify them.

Despite the imperfect state of our knowledge, decisions should and will be made about which option costs society least. The next question is whether the best option, in terms of total costs to society, will also seem best to the decisionmakers in the marketplace. Their purpose is to make profits, and therefore they consider only the process costs that they face under existing government regulations. If the market dictates a different choice, we have to ask how much costs to society would increase if there were no further attempt to influence the marketplace decision. But in our society the costs of additional government involvement may also be thought to be high. The question is whether the costs of further government involvement are higher than the increased damage, abatement, and avoidance costs that would be expected with no further government involvement.

If more government involvement appears desirable, how can government influence decisionmaking without piling on excessive transactions costs? Possible actions range from very little government involvement to complete government regulation or even ownership. The important point is that society should make a deliberate policy choice, with full consciousness of the tradeoffs between greater government involvement (with higher transactions costs) and less excessive environmental damages and avoidance costs.

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APPENDIX: CALCULATING ABATEMENT COSTS

The CEQ abatement cost estimates are based primarily on information provided by the Environmental Protection Agency, the National Commission on Water Quality, the Department of Commerce, and other federal agencies. This information is processed, supplemented when necessary, and checked against independent estimates in order to provide consistent estimates of total and incremental costs. The final estimates represent CEQ's best effort in realistically projecting actual expenditures over the coming decade. In some instances this has required balancing off feasible expenditure levels against the implied cost requirements of the legislation as determined by EPA and others.

TOTAL COSTS

The calculations begin with an estimate of "total" pollution abatement costs (see Table 16). These estimates include all expenditures reasonably allocated to collecting and treating wastes to prevent them from degrading the environment. For example, they include collecting and disposing of solid wastes, installing and maintaining sewers, building and operating waste water treatment plants, etc. For most industrial processes these estimates predominantly assume the installation of "end-of-the-pipe" pollution control equipment to treat the entire waste flow produced by the industry. This assumption understates the potential for changes in production processes, such as the recycling of process waters, which reduce the amount of wastes generated at a lower cost than would be required to treat them.

INCREMENTAL COSTS

The incremental cost estimates attempt to identify those costs which can be attributed to federal environmental legislation enacted since 1965. They are calculated by subtracting a CEQ estimate of baseline expenditures—expenditures that would have been made even in the absence of the federal legislation—from the total cost estimates. The "baseline estimates" are constructed on the basis of expenditure trends in evidence before the federal legislation was implemented.

A good example of the difference between total costs and incremental costs is provided by the solid waste cost estimates. As stated above, the total costs include all the costs of collecting and disposing of these wastes. Few of these costs, however, can reasonably be attributed to federal legislation; the wastes would have to be collected and disposed of regardless. The "incremental" solid waste costs, therefore, are associated with increased amounts of solid wastes that must be collected as a result of prohibitions on backyard burning or incineration without adequate air pollution controls and with increased disposal costs associated with efforts to eliminate air and water pollutants (e.g., the conversion of "open dumps" to sanitary landfills). For solid wastes the incremental costs are very small compared to the total costs. In other instances, such as industrial water pollution abatement, incremental costs approach total costs because little abatement is expected to have occurred in the absence of federal legislation.

Although it is impossible to estimate accurately what expenditures would be occurring in the absence of federal legislation, we believe that our baseline estimates are conservative—that is, lower than actual expenditures would be.

CAPITAL, O&M, AND ANNUAL COSTS

All calculations are initially based on estimates of the value of pollution control equipment in place before the federal legislation went into effect plus the value of investments made subsequently and projected over the next decade. All capital is valued in terms of its replacement cost in 1974.

These "capital-in-place" estimates are then used to calculate "capital costs," "operating and maintenance expenditures," and "annual costs." The capital costs are calculated by amortizing the capital-in-place over its economic life at a discount rate that approximates long-term borrowing rates. Thus the capital cost figures include depreciation of capital plus financing costs, implicitly assuming that all capital equipment is financed by borrowing.

Operating and maintenance costs are assumed to be a fixed percentage of the value of capital-in-place, a percentage that differs, of course, for different abatement techniques and for different industries.

Annual costs are the sum of the annual capital costs and the annual operating and maintenance costs described in the two preceding paragraphs.

SOME PROBLEMS

Any cost projections such as those undertaken by CEQ are necessarily very uncertain. The magnitude of the uncertainty is aptly demonstrated by changes in these estimates from one year to the next. Some of the changes are attributable to inflation. The 1975 estimates are all based on the 1974 prices, whereas the 1974 estimates were based on 1973 prices. However, more substantial changes usually result from revised estimates of how much equipment will be required and how much this equipment actually costs. For instance, the 1975 incremental cost estimates are $22.9 billion higher than the 1974 estimates, but just adjusting last year's estimates for inflation between 1973 and 1974 would account for approximately $20 billion of this increase. Adding 1983 and removing 1973 from the estimate also adds approximately $29 billion, so that the real costs for the years 1974 through 1982 are actually lower this year than last. Reduced O&M costs (because of a slower rate of investment) and reduced mobile source costs account for most of this drop.

The present estimates still contain other recognized uncertainties. In some instances, final pollution control regulations may not have been issued, leaving great uncertainty regarding the techniques that will have to be adopted to satisfy regulations. The most significant instance of this difficulty is with possible requirements for eliminating

Table 16

Estimated Total Pollution Control Expenditures, 1974–83[1]

(In billions of 1974 dollars)

Pollutant/medium	1974			1983			Cumulative—1974–83			
	O&M[2]	Capital costs[3]	Total annual costs[4]	O&M[2]	Capital costs[3]	Total annual costs[4]	Capital invest-ment	O&M[2]	Capital costs[3]	Total annual costs[4]
Air pollution										
Public	0.1	0.1	0.2	0.6	0.2	0.8	1.9	4.2	1.8	6.0
Private										
Mobile	4.1	1.0	5.1	2.7	6.1	8.8	35.2	32.7	37.5	70.2
Industrial	1.0	0.8	1.8	4.6	3.8	8.4	21.1	30.4	25.2	55.6
Utilities	0.6	0.4	1.0	3.4	2.5	5.9	14.7	19.7	14.6	34.3
Total	5.8	2.3	8.1	11.3	12.6	23.9	72.9	87.0	79.1	166.1
Water pollution										
Public										
Federal	0.2	<0.05	0.2	0.2	<0.05	0.2	2.0	2.0	0.3	2.3
State and local	1.6	5.6	7.2	3.2	9.4	12.6	43.9	19.4	78.4	97.8
Private										
Industrial	1.3	1.0	2.3	6.7	4.5	11.2	37.0	33.5	23.6	57.1
Utilities	0.1	0.1	0.2	0.7	0.6	1.3	3.3	4.4	3.7	8.1
Total	3.2	6.7	9.9	10.8	14.5	25.3	86.2	59.3	106.0	165.3

Radiation										
Nuclear powerplants	NA	NA	NA	<0.02	<0.03	<0.05	0.1	0.1	0.1	0.2
Solid waste										
Public	1.2	0.3	1.5	2.1	0.6	2.7	4.6	17.1	4.2	21.3
Private	2.1	<0.05	2.1	3.3	0.1	3.4	0.4	27.7	0.4	28.1
Total	3.3	0.3	3.6	5.4	0.7	6.1	5.0	44.8	4.6	49.4
Land reclamation										
Surface mining[5]										
Noise	NA	NA	NA	NA	NA	NA	1.1	NA	NA	NA
Grand total	12.3	9.3	21.6	27.5	27.8	55.3	165.3	191.2	189.8	381.0

NA=Not available.

[1] Incremental costs are expenditures made pursuant to federal environmental legislation beyond those that would have been made in the absence of this legislation.

[2] Operating and maintenance costs.

[3] Interest and depreciation.

[4] O&M plus capital costs.

[5] Not included in this year's estimate.

nonpoint source pollution to meet the 1983 standards established by the 1972 Amendments to the Federal Water Pollution Control Act. The costs associated with industrial point source "best available technology economically achievable" standards established by the act have been included for all industries for which such standards have been established or may reasonably be guessed at.

A similar type of problem exists in regard to new pollution abatement technologies—for example, whether new and less expensive technologies will be developed in the near future. This problem is particularly serious for the mobile sources cost estimates. They are all based on the assumption that the catalytic converter with its fuel penalties will remain the sole abatement technique through the beginning of the next decade, a conservative assumption that may result in a substantial overstatement of costs. The adoption of other existing technologies could make the actual costs much less.

Finally, the selection of the discount rates to be used in amortizing capital costs affects the annual cost estimates. In general, a rate of 8 percent has been used for private investments (10 percent for mobile sources) and 6 percent for public investments. Both rates are probably below the economist's estimate of the "opportunity cost" of investment funds, and both are below interest rates experienced during the past year, although a large proportion of investments is financed by industrial revenue bonds with interest rates lower than market rates for private issues. Using these rates tends to understate the financial cost of investments made during such high interest rate periods, but they are not unreasonable estimates for longer-term average rates. In addition, not all investments are financed by borrowing, so that the assumption that they all are, which underlies the total cost analysis, tends to overstate the financial costs.

ESTIMATES IN SPECIFIC SECTORS

AIR POLLUTION

The air pollution abatement cost estimates are based primarily on information updating the 1974 edition of *The Cost of Clean Air*[1] which was used for last year's estimates. This information was obtained by EPA for *The Economics of a Clean Environment*, which is currently in preparation.

Mobile Sources

The major source of air pollution in this category is the private automobile. Estimating automobile abatement costs involves projecting new car sales, the total number of automobiles operating with control devices, the number of miles that they are driven, their average fuel economy, and the price of gasoline.[2] These projections are combined with EPA, FEA, and NAS estimates of the initial and maintenance costs of pollution devices and the fuel penalty that results from their use.

Investment estimates are the product of the per vehicle costs for the pollution control device required in any year times the projected number of new car sales. This investment (including the replacement catalyst) is assumed to depreciate evenly over a 3-year average vehicle life. This assumption and a 10 percent interest rate are used to calculate capital costs. Maintenance costs are assumed constant over the life of the vehicle. Increased operating costs are those attributable to lower gas mileage resulting from the antipollution devices.

Investment and operating and maintenance costs for mobile sources other than private autos are based on data provided by EPA and represent a slight modification of the estimates contained in EPA's 1974 *The Cost of Clean Air*. Because the magnitudes of these figures are small relative to investment in automobiles, it is assumed that investment is evenly distributed over the period. This assumption is different from that employed in *The Cost of Clean Air* but does not significantly influence mobile source costs.

This year's estimates are lower than last year's because of improved information on investment costs, changed assumptions about the fuel penalty resulting from environmental regulations, and improved estimating procedures.

The costs of controlling pollution from all mobile sources is assumed to be entirely attributable to federal regulations. Therefore incremental costs equal total costs.

Stationary Sources

Investments for abating air pollution from stationary sources, including steam electric plants, are higher than last year's estimates in the aggregate, and significant adjustments have been made for individual industries. This year's estimates also include some sectors that were not covered last year.

The assumed economic life of these investments and the ratio of O&M costs to capital-in-place vary for different abatement techniques and for different industries, and the assumptions used in these projections are essentially those made in the 1974 *The Cost of Clean Air*.[3]

In calculating incremental costs, we took baseline expenditures from one of our special studies. It used essentially the same methodology adopted in a 1972 study of the pollution control equipment industry.[4]

Public Sources

These estimates include pollution abatement at solid waste and sewage sludge incinerators and the public costs associated with implementing and enforcing the clean air laws. This inclusion of transactions costs is a departure from previous years' estimates. A 6 percent discount rate was used in estimating annualized capital costs. Incremental costs are assumed equal to total costs.

WATER POLLUTION

INDUSTRIAL SOURCES

The cost estimates for water pollution abatement by industry are based on EPA internal estimates, on information generated in the preparation of *The Economics of a Clean Environment,* on contractor studies sponsored by the National Commission on Water Quality and EPA, and on industry-sponsored studies. Sometimes it was difficult to reconcile these sources, but the final estimates represent CEQ expectations of the maximum amounts that will be spent to meet the requirements established by the EPA guidelines (which some NCWQ contractors concluded would not satisfy the EPA effluent standards). This year's estimates are significantly higher than last year's because better information is available from the above sources. We were able to include costs associated with meeting the 1983 "best available technology" point standards for most industries, and the estimates have been expanded to include industries not included last year.

Investments in water pollution abatement are distributed over the decade with slight peaks in 1977 and 1983.

For annualized capital costs, a 15-year economic life and an 8 percent discount rate were used for most equipment. Annual operating and maintenance costs are related to the value of equipment in place according to information provided by the different sources mentioned above.

For the incremental cost estimates, the baseline estimate is taken from the same sources as mentioned above for air pollution.

Utilities

The cost of abating thermal water pollution from utilities is based on estimates supplied by EPA. These estimates assume some exemption of facilities from meeting the standards where thermal pollution is not a significant problem. Investment is distributed over the decade assuming that it will be a relatively smooth curve with peaks in 1978 and 1982.

In computing annualized capital costs, we used a 20-year economic life and 8 percent discount rate. Operating and maintenance costs are assumed to be 22 percent of the value of capital-in-place. Incremental costs are assumed equal to total costs.

Public Facilities

The estimates of the costs of abating water pollution from federal facilities were based on information provided by OMB and EPA.

For municipal sewers and sewage treatment plants, the cost estimates are based on estimates of federal obligations under the municipal grants program over the next decade. These estimates have been lowered somewhat from last year as a result of revised expectations about the size of the grants program in future years (in terms of constant 1974 dollars). This stream of federal expenditures is then adjusted to include the state and local share of federally funded facilities, municipal sewers that are not partially funded by the federal government, and sewers installed by private developers.

An economic life of 25 years and a discount rate of 6 percent were used to calculate annualized capital costs. The estimate of operation and maintenance costs required an assumption about the relative proportion of investment allocated to different types of treatment plants because each has its own ratio of operating and maintenance costs to investments costs.[5]

For incremental costs, the trend in investments from 1958 to 1965 was extrapolated on the basis of increased population served by municipal plants and increased sewage flow per capita.[6] This definition of the baseline is similar to but less than that obtained by a simple extrapolation of per capita or total expenditure trends prior to 1965. The baseline estimates also assumed that a lower proportion of secondary and tertiary treatment plants would be built, thus lowering the ratio of operating and maintenance costs to capital-in-place.

NOISE

The estimated noise control costs include modifications to commercial aircraft, trucks, and trains. All estimates are based directly on information provided by EPA and on Department of Transportation studies. The substantial reduction from last year's estimates simply reflects revised EPA estimates. Incremental costs are assumed equal to total costs.

RADIATION

The estimated costs of radiation control from nuclear powerplants include only the additional costs for equipment required to treat air and water effluents in order to reduce radiation emissions below the original AEC (now the Nuclear Regulatory Commission) standards. The cost estimates were provided by the AEC and are assumed to represent both incremental and total costs.

SOLID WASTES

The solid waste cost estimates were based (1) on EPA estimates of per capita waste generation and unit cost estimates for collection and disposal[7] and (2) on CEQ estimates of the relative importance of different disposal methods and the proportion of total wastes that are collected and disposed of by private and public enterprises. These total cost estimates are then allocated between the public and private sectors, assuming that two-thirds of residential and commercial wastes and 90 percent of industrial wastes are collected by private firms and that 10 percent of the former and all the latter are disposed of privately.[8]

In calculating incremental costs, we assumed that under the baseline case a smaller proportion of wastes would be collected and that disposal costs would be lower (assuming more use of open dumps).

LAND RECLAMATION

Because no federal strip mining bill has been enacted, land reclamation costs have not been included in this year's incremental cost estimates.

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CHAPTER 5

A GLOBAL ENVIRONMENT

Can the earth provide enough food for all the people living on it? This question is of fundamental importance to the quality of the human environment. In the developing world, where nearly three-quarters of the earth's people live, adequate food for growing populations is seen as the overriding environmental problem.

Food production also affects environmental concerns defined more narrowly. Producing enough food for a constantly increasing human population places increasing demands on resources and the environment. The use of land and water, methods to fight pests, consumption of fertilizer and energy—each of these raises issues which directly link food and environmental quality.

The earth today has four and one-half times as many people as it did in 1798, when Malthus warned that starvation would hold population in check. How many people can the earth support? There is no certain answer. Yet we do know that there are limits to the earth's ability to absorb the ecological stresses of modern technology, agricultural as well as industrial. Not only food but other essentials for quality of life are threatened by the pressure of population growth.

Food and population were the subjects of special conferences convened by the United Nations in 1974—the World Population Conference in Bucharest in August and the World Food Conference in Rome in November. The food conference opened at a time of outright starvation in the African Sahel and of critical food shortages in

Bangladesh and India, underlining the need for practical international action against famine.

The conferences did not and indeed were not expected to "solve" the problems that they addressed. They made beginnings in some areas and continued progress in others. A large part of their value was in emphasizing that these fundamental problems affect the whole world and require cooperative action by many nations.

This chapter will consider several major environmental matters of worldwide concern, devoting special attention to food. The related problem of population growth, more briefly treated here, is discussed at length in our Fifth Annual Report. The chapter also notes the contributions that international bodies have made in these areas and their potential for further positive action.

FOOD

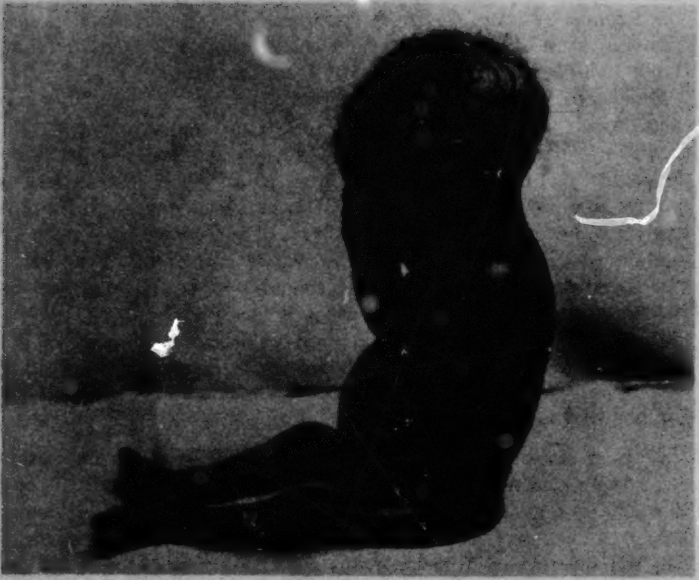
HUNGER IN THE MODERN WORLD

Hunger is as old as mankind. But human ingenuity has at times created revolutionary expansions of food production.[1] This happened in neolithic times when human beings first began to select and plant food crops instead of simply garnering them from nature. It happened again when farmers learned to use chemical fertilizer and to substitute mechanical energy for human and animal muscle power.

A decade ago, at the outset of the "Green Revolution," there was hope that another revolutionary expansion had occurred and that mankind might finally conquer the age-old enemy of famine. New strains of wheat, rice, and other food plants, together with scientific approaches to animal husbandry, promised to keep the global food larder full.

By the early 1970's, however, the threat of famine was back, with drought and starvation in the Sahelian region of Africa. In 1974, hunger was widespread on the Indian subcontinent, food supplies were low in many other countries, and basic grain prices had risen threefold or more in a brief year or two. Grain prices dipped somewhat in 1975 but were still more than double the levels of 1972.[2]

Never in history has there been assurance of enough food for all the world's people. But despite great expansions of world food production, the situation today is in some ways more critical than ever. The Food and Agriculture Organization of the United Nations reckoned that in 1970 at least 460 million people (excluding Communist Asia) were suffering serious food deficiency. This estimate undoubtedly understates the number of people enduring privation from hunger, for it is based on the amount of food needed to do no more than subsist; it does not even allow for moderate activity.[3]



This Kenyan child is among the 10 to 20 million children in the world who suffer from kwashiorkor and marasmus, severe protein-calorie malnutrition diseases.

Young children suffer the most from hunger. In resource-poor countries of the Third World, the majority of children are undernourished at some time in the first 5 years of life.[4] It is estimated that 10 to 20 million young children are severely afflicted with the protein-calorie malnutrition diseases of kwashiorkor and marasmus; most will die without treatment.[5] Another 200 million suffer from milder forms of malnutrition.[6]

Figures on direct death from starvation vastly understate the actual toll. A malnourished child cannot resist infections that might be trifling to a well-fed child. Fatality rates from measles, for example, approximate 15 percent in many poor countries. They are 180 times higher in Mexico than in the United States; in Guatemala, 268 times higher; and in Ecuador, 480 times higher.[7]

Of 35,000 deaths of children under 5 years in 10 Latin American countries, 5 percent was due directly to starvation, but in 57 percent of the cases, malnutrition was an underlying cause of death.[8] Moreover, malnutrition in infants can cause permanent mental retardation.

Special dietary deficiencies common among poor people cause diseases that have largely disappeared from the developed world. These include endemic goiter, with the cretinism that often accompanies it, for lack of iodine, and iron deficiency anemias, which affect up to 15 percent of men, 35 percent of women, and more than one-half the children in some Latin American communities.[9] Vitamin A deficiency is a major cause of blindness; in the Far East alone, it is estimated that 100,000 children go blind every year from this cause.[10]

Food shortages have not diminished much in the past 20 years, even though world food production sufficiently outpaced population growth to permit increases of about 1 percent per year in worldwide per capita consumption. In developing countries, the poorest one-quarter to one-third of the people, who barely have enough food to stay alive, benefited little if at all. Most of the growth in food production was in developed countries, where rising outputs of grain stimulated the meat-eating habit. Although poor countries as well as rich increased food production by some 3 percent per year, this increase barely exceeded population growth in poor countries of 2.5 percent a year—compared with 1 percent in developed countries.[11]

Causes of the Food Crisis

In poor countries, then, hunger is nothing new. But in the last 3 years there was a sudden, alarming deterioration—a crisis of food shortages and soaring prices. By mid-1975 the immediate crisis had abated, and there were hopes for good harvests in most of the world. Yet the underlying situation, with world grain stocks severely depleted and prices still high, remained precarious. There was a widespread feeling of near-Malthusian pessimism, or at least a conviction that the world had entered an era of chronic scarcity and higher food prices.[12]

What had happened? Were transitory factors responsible for the crisis, or had a long-run change set in? And what are the long-term prospects for the earth's ability to grow enough food for all its people? Several explanations have been offered for the crisis. The leading immediate causes appear to be threefold.

First, in 1972 the whole world experienced a slight decline in food production—for the first time in 20 years.[13] World output of grain, some 1.1 billion tons, dropped 33 million tons from the year before. Crop failure in the USSR was massive; the grain harvest was 168 million tons, down 13 million tons from 1971. To meet the shortage and their citizens' rising appetites for grain-fed meat, the Soviets and Eastern Europe bought 27.3 million tons of grain in 1972–73; their usual imports were about 4 million tons.[14] The huge grain purchases drew down stocks in the major exporting countries to a 20-year low.[15]

Second, the United States and Canada, the major exporting countries, had adopted deliberate policies to reduce production until their grain surpluses were gone and then to let the free market take over. Between 1967 and 1972, the United States cut wheat acreage from 59 to 48 million acres and its feed grain acreage from 103 to 96 million acres. Canada reduced wheat acreage from 31 to 22 million acres. As a result, 100 million fewer tons of grain was grown in those 6 years than would have been grown had acreage remained at the 1967 level.[16] Grain reserves in the major exporting countries at the end of the 1973–74 growing season were 56 million metric tons—half what they had been 2 years earlier.[17] Thus there was not much left in the world's larder to meet an emergency.

Third, the emergency arrived; grain crops in the Indian subcontinent were disappointing for 3 years in a row, and the 1974 winter crop failed badly. The situation was even worse in Ethiopia and the Sahelian countries of West Africa, where after several years of drought there was widespread, severe famine. The exact toll is uncertain, but thousands of people are known to have died.[18] The shortages in Bangladesh and India, though less dire, had a greater effect in the world food market because of the huge numbers of people involved.

India imported 3.6 million tons of grain in 1974. In 1975, she was forced to buy 7 million tons to supplement the very poor summer crop of 1974, which followed a bad season of drought and floods.[19]

Many of the causes of the recent crisis were transitory. Crop failures are recurrent misfortunes, but they are not unremitting. Today there is widespread international support for rebuilding grain reserves, although the policy questions of how much to stock and how to do it remain unsettled. The United States and Canada have lifted restrictions on crop acreage, and high prices have encouraged farmers in the world's best granaries to plant more. Since 1972, U.S. acreage planted has risen sharply.[20] The disastrous summer drought and early frost of the U.S. 1974 growing season wiped out what would have been a bumper crop, but at midyear the prospects for 1975 appeared bright, assuming normally good weather.

The Long-Term Outlook

Underlying such temporary difficulties as those that caused the 1974 food crisis are persistent problems which make the long-term outlook sober.

First and greatest is population. In developing countries, population growth rates average nearly 2.5 percent—a rate at which populations double every 28 years. India's 600 million people increasing at this rate would amount to 1.2 billion just after the turn of the 21st century.

Postwar public health measures reduced death rates in developing countries from 35 per 1,000 people to 18 per 1,000. But birth rates generally declined little, remaining near 40 per thousand.[21] Only truly remarkable improvements in agriculture have enabled food output to keep pace with the number of new mouths to feed. Yet the danger that population growth will outstrip food production remains. The United Nations *Assessment of the World Food Situation,* prepared for the Rome Conference, estimated that if recent population trends continue, the poorer countries would have to import 85 million tons of grain per year by 1985, compared with about 18.6 million tons in 1970–72 and 37.5 million tons in 1975.[22] Further discussion of world population growth and its implications may be found in the following section and in the last Annual Report.

In the late 1960's the Green Revolution raised hope that at last poor countries could feed themselves adequately. The past 4 years have dampened that hope. Although the Green Revolution has helped keep food production in developing countries abreast of population growth and has surely saved millions of people from hunger in the past decade, it is subject to natural limitations.

In India, 4 fat years of good weather and fine harvests from the Green Revolution's high-yielding wheat and rice varieties led to an annual growth rate of 4.5 percent in grain output from 1967 through 1971. Unhappily, 4 leaner years came after; none of the following four harvests matched that of 1970–71. Meanwhile, population rose an estimated 54 million.[23]

Although acreage sown to high-yielding wheat and rice has expanded each year, improvement in yields has slackened. In India, Green Revolution wheat still provides 2.5 times the yields that traditional varieties did—but that is a drop from an earlier advantage of nearly 4 to 1.[24] Part of the reason for the decline is simply that the best land was planted to high-yielding varieties first.[25] Further, high-yielding varieties of grain demand a regular supply of water, and they thrive best with plenty of nitrogen fertilizer. Pesticides are also part of the recommended culture. All these elements of Green Revolution agriculture require scarce resources, energy, and cash.

Last year's fourfold increase in oil prices—three-quarters of it posted on one day, at the January 1, 1974, meeting of the Organization of Petroleum Exporting Countries—compounded the difficulties facing agriculture in the developing world. High-priced oil runs irrigation pumps and farm machinery, and petroleum hydrocarbons (natural gas, naphtha, and oil) are raw material for nitrogen fertilizer. The oil price rise played a subsidiary part in tripling fertilizer prices between 1971 and 1974; fertilizer prices were already rising sharply as demand increased and the surplus production capacity of the early 1970's vanished. But it virtually guarantees that prices will not return to the previous low level.[26]

Feeding Grain to Animals in a Hungry World

Another factor often mentioned as a problem for food-short developing nations is the rising demand for grain-fed meat in affluent nations. Poor people depend chiefly on starch for food—wheat, rice, potatoes, corn, or whatever. Much less land and labor are needed to produce 1,000 calories of starchy staples than of any other kind of food. Grain in particular is a good nutritional bargain; combined with legumes and other foods that complement its proteins, grain can be as nutritious as meat. But to produce 1 pound of meat, animals must eat from 2 to 10 pounds of grain.

As their incomes rise, however, people all over the world have demonstrated a preference for more meat in their diets. It is easy

Green Revolution wheat helped to buy time for developing countries by raising food output while populations increased.

to follow the progress of affluence through history or among nations by looking at the starch content of the typical diet. One hundred years ago, starchy staples—especially bread and potatoes—provided 55 percent of the calories in the average U.S. diet; today starchy staples provide only about 20 percent.[27] In recent years we have consumed 1,650 pounds of grain per person per year, but only 200 pounds of it directly. Most of the rest was consumed indirectly in animal products such as meat, milk, and eggs. By contrast, people in developing countries consumed about 350–550 pounds of grain each year, some 300 pounds of it directly.[28]

The same shift in diet that took place in the United States is occurring in Europe, Japan, and the USSR. It underlies the steady growth in grain consumption in developed countries, about 2.5 percent per year in the past decade and a half.[29] The high income countries, with about 30 percent of the world's population, produced and consumed more than 50 percent of the world's grain output from 1969 to 1971. In 1973–74 as the food crisis deepened, developed nations imported 72.4 million tons of grain, most of it for meat animals, while developing countries imported 62.4 million tons, nearly all of it intended for human beings.[30]

Heavy meat consumption in the developed world and the nutritional inefficiency of feeding grain to animals were often criticized at the 1974 Food Conference in Rome; the same criticisms, frequently couched in moral terms, have been raised subsequently.[31]

Yet international disparities in grain consumption arise from several factors, and a reduction of meat consumption will not automatically free grain for the hungry. Food grains for human consumption and feed grains for animal consumption are not generally interchangeable, even though the land to produce them generally is. More important, decisions by people in one country to forgo meat do not directly provide food to people in another country. The history of the 1950's and sixties shows that an abundance of food and low export prices in the affluent countries do not necessarily cure the chronic shortage of food in poor countries.

Disproportionate grain consumption in the developed nations is more a symptom than a cause of hunger in the developing nations. The basic causes are inadequate food production capacity and income in the poor countries. The best long-run solution to the problem of world hunger has three parts—control of population growth, economic development to provide people with enough income to buy an adequate diet, and development aid to raise food production in poor countries. The following section concerns the third part of this solution.

RAISING WORLD FOOD SUPPLIES

There are essentially two ways to increase food supplies in the Third World, cultivate more land and increase production on land already under cultivation. Each has environmental consequences—not invariably bad ones. Rene Dubos has drawn attention to the beauty, order, and stability of the French countryside, which has been farmed for thousands of years with no loss of fertility.[32] This carefully tended land is diverse, aesthetically rewarding, and more favorable to the growth of civilization than it was in its natural state.

Yet for every instance in which man's activities have improved upon nature, others may be found where man's tampering with stable natural ecosystems has degraded the environment. For example, attempts to turn tropical forest land into pasture for cattle have often failed after a few years as the benefits from the forest cover of water retention, soil enrichment, and temperature control are lost.[33] Use of chemical pesticides to raise yields provides other examples. Lindane used in irrigation water to control the rice stem-borer kills the fish that are traditionally raised in Southeast Asian rice paddies and that add valuable protein to the local diet.[34]

The world needs more food, not only for the one-half billion hungry people already living in it but also for the 2 or 3 billion more who are likely to be added by the turn of the 21st century, even with a worldwide decline in birthrates. Feeding these people will inevitably involve environmental problems.

The following sections point to some of the problems that we know about. More will come to light as agricultural development proceeds. But whatever the problems, we must learn to provide more food a decade or two from now than we do today if we are to avert more widespread hunger than the world has ever known.

Cultivating More Land

The world as a whole is not running out of land. This is the judgment of both the U.S. Department of Agriculture and of the UN team that prepared the world food assessment for the Rome conference. Citing recent studies, the USDA concluded that there is at least twice as much land in the world suitable for farming as the 3.4 billion acres now in use.[35] The UN assessment stated that many millions of hectares of arable land remain unused, especially in Latin America and Africa.[36]

But even these optimistic assessments point out that much of this land is not where it is needed. The poor but populous countries of India, Bangladesh, and Egypt have little if any room to expand. Large areas of unoccupied land in Latin America, Indonesia, and the Philippines are primitive and remote from civilization.

More important from an environmental standpoint, the natural ecosystems in many of these "primitive" areas serve essential purposes. The dense leaf cover of the tropical rain forest, for example, insulates the earth, keeps it cool, preserves moisture, and constantly supplies humus. The forest itself produces timber and provides habitat for wildlife. When the forest cover is removed, the soil is exposed to the full power of the sun, and soil temperatures commonly rise 20 to 40 or even 60 degrees. Microbes which condition the soil cannot long continue their work at these temperatures. The chemical and physical nature of the soil changes; it rapidly loses its fertility and becomes compact and hard as brick.[37]

The traditional agriculture of the poorer soils in the humid tropics is shifting cultivation or slash and burn. The farmer clears a bit of forest, burns the trees, uses the ash for fertilizer, and works the land for 2 or 3 years until its fertility is dissipated. Then he and his family or clan move on, leaving the cleared land fallow for many years—often decades—until the natural forest cover returns. For sparse populations on level land, this method is ecologically workable, but it cannot support growing populations.[38]

Another difficulty in opening more tropical land to cultivation is the tsetse fly, which has carried the cattle-killing disease trypanosomiasis to more than one-third of Africa.[39]

In drier regions, land may be more suitable for grazing than for crop cultivation. The danger of grazing too many domestic animals in fragile, semidesert ecosystems is well known. Overgrazing, together with cutting forest for fuel wood or for raising crops, denudes the countryside and creates conditions for rapid soil erosion and the spread of deserts. Land formerly under cultivation in Africa, Asia, the Middle East, and the South American countries of the Andes is being abandoned because severe soil erosion—caused by overgrazing or deforestation—has made it unproductive.

Saving old farmland is more crucial than adding new in many places. All over the world good farmland is being irretrievably lost by urbanization; by poorly managed irrigation, leading to water logging or a buildup of salinity in the soil; and by soil erosion or flooding from deforestation. Despite land losses, few countries have policies to protect farmland.[40]

In developing countries, a considerable portion of the growth in food output over the past 15 years came from expansion into new agricultural lands. Between 1960 and 1971, area planted to grain increased by more than 1 percent per year in the developing world as a whole and by 2 to nearly 4 percent in parts of Latin America and Africa. In developed countries in the same period, rising output was due entirely to better yields; while grain production rose, the area planted declined.[41]

Altogether, poor countries in the developing world cultivate about twice as much land as rich countries—but produce 20 percent less food.[42] Improving yields appears to be the best hope for most of these countries.

Raising Yields

Improving yields is no mystery. It requires more water and fertilizer, energy to power irrigation pumps and run farm machinery, better pest control, and improved plant varieties. The trouble, of course, is that these resources are scarce and costly. It is difficult for poor countries to obtain enough of any of them; making them available on a broad scale to most of their farmers, poor as well as rich, requires a complex, integrated set of social, economic, and technical actions.

These difficulties are compounded by the environmental implications of agricultural development. Countries where hunger is common must give first priority to feeding their people adequately. Yet the principles of ecology caution against losing sight of the long-term effects of strenuous efforts to meet this goal.

Water A prime resource for increasing food output is plentiful water. The fresh water supply of the world is limited; it is generally thought to be the greatest single constraint on the expansion of food production.

The 15 percent of the world's cropland which is irrigated provides 30 percent of mankind's food.[43] Adequate water is a prime requirement both for growing high-yielding grain varieties and for multiple cropping—using the same land to produce more than one crop a year. Surface irrigation, the oldest and cheapest form of artificial water supply, has been practiced for millennia on every continent. Counterbalancing its value are some serious environmental problems. Without proper management, irrigated land may become waterlogged and saline. Irrigation water percolating downward and accumulating underground may gradually raise the water table to within a few feet of the surface. Too much water around plant roots inhibits growth, and as the water evaporates, it leaves salts behind in the upper few inches of soil, ruining the land. Salinity is a particular hazard in hot, dry climates where evaporation is rapid.

There is evidence that the sequence of irrigation, waterlogging, and salinity led to the decline of ancient civilizations in the Middle East.[44] The water table has risen near the surface on almost 5 million irrigated hectares of the Indus Plain in India and Pakistan; both waterlogging and salinity are severe on nearly 1 million hectares.[45] In recent years, tubewell irrigation—irrigation from wells that tap the high water table—has replaced part of the old canal and ditch system. By lowering the water table and flushing the soil, tubewell irrigation has helped reclaim some of the land.[46]

Another serious problem with surface irrigation is its connection with disease. An estimated 100–200 million people in continuously irrigated tropical areas now suffer from schistosomiasis, a debilitating disease that causes fever, diarrhea, and lassitude in adults and can be fatal to children. The disease is caused by a parasitic fluke (or worm) which cycles back and forth between man and freshwater snails as hosts.

In Egypt, for example, the Aswan Dam has stimulated a huge increase in schistosomiasis. Yearround irrigation permits growing four crops per year instead of one, but yearround water in irrigation ditches also provides a perfect environment for the host snail. Although pre-

Waterlogging and salinity from canal and ditch irrigation have damaged millions of acres of farmland in Pakistan and northwest India.

cise figures on the disease do not exist, one specialist estimates that 50 percent of the rural people in Egypt (some 15 million people) is now infected with the disease, compared with 5 percent before the dam. The Volta Lake in Ghana has had a similar effect.[47]

Tubewell irrigation or underground systems that deliver water to plants through conduits would almost certainly help control schistosomiasis by eliminating some of the standing water of surface irrigation systems. Subsurface drain tile systems are now being tested in Egypt.[48]

The apparent success of tubewell irrigation in Pakistan and Northwest India indicates that some age-old environmental problems may be avoided if irrigation systems are designed and used with care. Of course, tubewells cannot provide unlimited water. Even in the Indus and Ganges plains, where ground water is fed by Himalayan snows, there is a limit to the water that can be withdrawn. In other less-watered areas, ground sources have been tapped excessively and wells have run dry.[49]

Many developing countries can make better use of the water that they have. It is important to conduct careful studies on such water supply problems as how to catch and store rainwater that would otherwise run off, how much water may safely be withdrawn from underground, and how best to bring water to the fields. Improved tech-

Tubewells tap the underground water table to irrigate rice fields at Comilla co-operative, Bangladesh.

nology such as drip and trickle irrigation or systems for light, frequent watering offer opportunities to use water more frugally.[80]

It is easy enough to point to the possibilities but difficult to accomplish them. Extension and improvement of irrigation make demands for capital in the desperately capital-short countries that most need more food output. Operating the systems also requires energy.

Energy and Fertilizer It may be very unwise—indeed impossible—for the developing world to pattern its agriculture on the energy-intensive, high technology methods of the U.S. food system. But greater use of energy from fuel (rather than human or animal musclepower) and more efficient use of every source of energy are essential to raising food production in the developing countries.

Nitrogen fertilizer will probably represent the major use of energy on farms as development proceeds. Power for irrigation is another important use. According to one study, a penny's worth of electricity at 5 cents per kilowatt hour can provide as much water as a man working a hand pump all day.[51] Mechanization of certain tasks that have very high peak labor requirements, such as plowing or threshing, may prove a third significant use for energy.

The increased food output of the developing countries in recent years reflects in part the rapidly growing use of energy-intensive nitrogen fertilizer. Overall, the developing countries increased their fertilizer use by 14 percent annually in the years 1967–71, when it was plentiful and cheap. All this came to a halt in 1973–74. Bangladesh actually cut fertilizer consumption. Several developing countries reported no increase, and India's increase was only 3 percent, compared with an annual average of 13.5 percent since 1967.[52]

The U.S. Department of Agriculture has forecast that fertilizer prices will decline as plant capacity is expanded.[53] Even so, they are not likely to return to the low levels of the early 1970's because of high petroleum prices. It will be an enormous drain on the poor countries—especially on their severely limited foreign exchange—to import fertilizer, petroleum to make fertilizer, or oil to power irrigation pumps and run farm machinery. Countries like India and Bangladesh, which were forced to buy emergency food supplies at record high prices in 1974, are in a worse position than ever to purchase energy. The poor countries will need help from the developed world and the petroleum-rich nations to cope with vastly increased energy prices and doubled grain prices.

There are some avenues of self-help that warrant exploration. A recent study for the Ford Foundation's Energy Policy Project emphasizes a flexible approach, making full use of all the energy sources that the poor countries possess, including the traditional ones of wood, dung, and vegetable wastes.[54]

The study stresses the potential of biogasification plants in scattered rural villages. This system uses anaerobic fermentation to produce methane gas, fertilizer, and high-grade livestock feed from farm "wastes," crop residues plus animal and human wastes. In some cases, the capital costs of village biogas systems could be half those of central electric powerplants and large fertilizer factories. According to the report, there is enough potential energy in the farm wastes of most Third World villages to make them self-sufficient in fuel and fertilizer.[55]

Although chemical fertilizers can help raise world food supplies, they may also have serious environmental consequences. There is a biological limit to the amount and speed with which plants can take up nitrogen for extra growth. As more fertilizer is applied, the returns in added output diminish. Some of the nitrogen that the plants cannot use leaches out of the soil and runs off into streams and lakes. There it pollutes the water through eutrophication—a super-abundance of nutrients leads to excessive growth of algae and weeds, then to oxygen depletion, and eventually to a breakdown in the balance of the ecosystem, with extensive kills of fish and other aquatic life.

In affluent countries, eutrophication is common, although it is not always clear how much is due to nitrogen and phosphates from fertilizer use on the farm and how much to industry, to wastes from feedlots, and to domestic sewage. Poor countries, using less fertilizer, experience the problem less. Yet reports of eutrophication have come from the developing world too. For example, Filipino villagers have found that fertilizer in rice paddies has led to eutrophication of lakes and ponds and to the loss of the fish that are a valuable source of protein.[56]

A broader question than that of fertilizer use is whether the highly industrialized, energy-intensive food production system of developed countries can or should be transplanted to poor countries. With the aid of fossil fuel energy, the United States grows a prodigious amount of food. Expenditure of energy on the farm is moderate in relation to total U.S. energy consumption—3 or 4 percent of the total—but large in absolute terms.[57] One study concludes that in 1970 it took the energy equivalent of 80 gallons of gasoline to raise 81 bushels of corn on 1 acre in the United States.[58]

The U.S. system has substituted fossil fuel energy for other resources, most notably human labor. For developing countries short of fossil fuels, the substitution would be no bargain. Alternatives that conserve fossil fuel energy, instead emphasizing local renewable energy sources and plentiful labor, are more suitable to their resources. These alternatives are likely to be sounder environmentally as well.

Possibilities for energy conservation in the developing countries include:

- Scaling farm machinery to fit the job and running it at efficient speeds
- Integrated pest management, with stress on biological controls and manual application of chemical pest and weed killers where they are necessary (mechanical spraying requires 60 times as much energy as hand treatment)
- Rotation of corn and other grain crops with legumes, which fix nitrogen and thus reduce the need for chemical fertilizer.

We have already alluded to the potential for energy, fertilizer, and feed production through biogasification. According to one study, a combination of several organic, labor-intensive methods might produce yields as good as those of U.S. corn culture while using half as much fuel energy.[59]

It is worthwhile to emphasize the possibilities of relying more on organic, recycled energy sources in farming and less on fossil fuels, but not to exaggerate them. The People's Republic of China appears to nourish 800 million people adequately, largely through traditional practices. Using only 11 percent of her land for growing food, China relies heavily on irrigation, multiple cropping, and intensive use of human, animal, and crop wastes. China's system is highly productive in terms of output per unit of land.[60]

Even so, China's consumption of chemical fertilizer has risen sharply since the early 1960's. For several years, China has been the world's largest importer of nitrogenous fertilizer. Domestic production from lignite is presently expanding, and China plans to produce natural gas or crude oil-based fertilizer in 1978.[61] The lesson appears to be that even in a traditional agricultural system, chemical fertilizer has an essential place in raising yields.

Better Plant Varieties Genetically improved plant varieties are responsible for much of the worldwide increase in crop yields since World War II. In recent years, hopes for further increases have been raised by Green Revolution varieties such as the short, stiff-stalked, heavy-headed, fast-maturing wheat that Dr. Norman Borlaug and his associates developed after 30 years of work.

"Green Revolution" refers not only to high-yielding varieties of wheat and rice themselves but also to the package of techniques and resources necessary for their success—water control, fertilizer, pesticides, and in some cases farm machinery. This package is continually evolving, especially through breeding new characteristics into the plants.

An essential feature bred into the plants is their ability to take up much larger quantities of fertilizer than traditional varieties can; that is why their yields are high. Critics have questioned this feature on grounds that there are environmental risks to heavy use of fertilizer and that the energy resources needed to make chemical fertilizer are too expensive for poor countries.

In India, Pakistan, and Bangladesh, farmers use far less than the recommended doses of fertilizer on high-yielding wheat and rice.[62] According to the U.S. Department of Agriculture, high-yielding grains respond better to limited amounts of fertilizer than do most of the older varieties and indeed do as well or better with no fertilizer at all.[63] Thus it appears that whatever may be said of the wisdom or necessity of heavy fertilizer use, Green Revolution grains generally use it with superior efficiency.

The high-yielding grains do appear to be less drought-tolerant than older varieties, and high-yielding rice cannot take too much water. Plant breeders are attempting to improve both these characteristics.

When the Green Revolution wheat developed in Mexico was first planted in Asia in the late 1960's, there was real danger that the new variety would succumb to local diseases. Luckily, there was no ruinous epidemic. The new varieties proved to have good resistance to the local diseases, and they have since been crossbred with local varieties to improve resistance.[64] This is a never ending job, however, because mutations in the organisms that cause disease continually occur,

High-yielding rice shown here at harvest in Vietnam is bred to take up more fertilizer than traditional varieties.

enabling them to attack formerly resistant plants. Generally it takes about as long for the mutations to occur as it does for plant breeders to develop new resistant varieties.[65]

Finally, there is the seemingly simple matter of seeds. The job is not finished when plant breeders release a new improved variety; seed incorporating the new features must be multiplied and put in the hands of farmers. In developing countries, seed quality is sometimes poor, and farmers themselves may add to the problem if they try to skimp by saving seed from the previous crop rather than buying new seed.[66]

Pest Control Disease, insect pests, and weeds cause an estimated 30 percent loss of potential food production worldwide.[67] No part of the world's food, fiber or feed supply is immune. Despite the efforts of modern technology, on occasion pests can still attain the awesome destructive power of a Biblical plague.

The locust—or grasshopper—does spectacular damage. A swarm may number 1 billion insects, spread over 200 square miles, and ravage 3,000 tons of grain in a day. Locusts in Ethiopia have eaten more than 100,000 tons of grain in one summer. The quelea, or locust bird, of Africa is a robber on a large scale; these birds have been known to eat 3,000 tons of grain per day in the Sudan.[68]

Environmentally, the best approach to pest control is to use natural forces as an ally and chemicals as an adjunct. The goal of a system of integrated pest management is not to eradicate totally but to keep the pest population low enough for man's needs while disturbing natural controls as little as possible. Integrated pest management keeps pests within bounds by such preventive measures as quarantine at entry ports and production of weed-free seeds, by breeding plants for

Swarms of desert locusts in Ethiopia eat as much as 3,000 tons of grain in one day.

disease resistance, by proper culture, and by biological controls, including the use of the pests' natural predators. Integrated pest management often provides better control, at lower cost, and with far fewer environmental problems than reliance on chemical pesticides alone.[69]

Events in Peru's Cañete Valley, where the cotton crop was heavily treated with DDT and other chlorinated hydrocarbons, illustrate the effects of indiscriminate spraying. The sprays killed the pests, but they also killed the predators of the pests. The pests then developed resistance to DDT—and their natural predators were gone. The cotton crop recovered only when overall spraying was abandoned in favor of spot use of pesticides, predators were reintroduced, and planting and harvesting were timed to avoid the worst of the pest infestation.[70]

On the plus side of the ledger, chemical pesticides are widely available, are versatile, and act quickly, especially where pests are very numerous. They work for the single farmer even if his neighbor takes no action to control pests, and the equipment to use them is readily available in many parts of the world.

Part of the Green Revolution package is chemical pesticides. For wheat, disease is the chief threat, especially the ancient disease of wheat rust. There are two lines of defense against disease—chemical fungicides and plant breeding. Both are used by Green Revolution scientists. New wheat varieties, the result of crossbreeding, are apparently more disease-resistant than traditional varieties.[71] However, as North American wheat growers have long been aware, it takes vigilant rotation of varieties and constant introduction of new strains to guard against disease and reduce the need for chemical fungicides.

The major pest problem with rice is insects. Controlling them poses a real dilemma because the very culture that produces higher yields at the same time increases the risk of insect attack. Close planting, luxuriant foliage, and multiple cropping all contribute to a buildup of insects.[72] The rice whorl midge, for example, was no problem in the Philippines until irrigation and continuous cropping became common. Today this insect devours as much as 25 percent of the rice crop. Heavy use of fertilizer also seems conducive to pest problems, as in India, where the rice hispa beetle caused much more damage in fields where nitrogen was used than in unfertilized fields.[73]

There is evidence that peasants in poor countries apply much smaller amounts of pesticides to Green Revolution varieties than advised, probably for the same reason that they also use less fertilizer—high costs.[74] Precisely how much is being used and how they are affecting the complex living systems of food production in developing countries are not known. There are reported instances of ill effects from using pesticides, especially such toxic ones as lindane, which is banned for agricultural use in the United States.

If developing countries must choose between using chemical pesticides that are known to harm the environment or losing a crop, they may well choose to save the crop. The choice may not always be necessary. The multifold approach of integrated pest management could prove at least as valuable to the Third World as to industrialized nations.

Developing nations import virtually all their chemical pesticides. Most of the resources required for integrated pest management are human and natural—agricultural scientists continuously developing resistant plant strains, field agronomists to help farmers learn pest control methods, field "scouts" to monitor progress, and from the natural world, predators and pathogens. None of these has to be imported. They may be found or trained at home.

An authoritative ecological assessment of development agriculture has yet to be made. Continuing changes in the breeding and culture of high-yielding plants are responding to some of the early criticism of the Green Revolution. Among them are efforts to crossbreed for drought and disease resistance and to use the same land for high-yielding grains and legumes either simultaneously through interplanting or successively through crop rotation.[75]

Several agricultural scientists have suggested reconsidering the Green Revolution emphasis on monoculture (planting large plots to one uniform variety). It may be that monoculture is well-suited to temperate zone farming for profit but is not so well-suited to peasant farming in hot climates; monoculture is inherently more vulnerable to disease and to insects. Greater diversity both in crops and in plant varieties may offer more safety to the small field farmer in poor countries.[76]

Most of this discussion has focused on technical and scientific methods to help achieve a long-run increase of food output in the developing world. It leaves out the whole social and economic dimension. Questions of equitable distribution of food, land reform, credit for small farmers, planning to add productive jobs while raising the yield from croplands in the great populous, underemployed, underfed Asian countries—all these and many other social issues demand as much attention as technology in the effort to develop adequate food production for all the world's people.

THE UN FOOD CONFERENCE

The World Food Conference, convened in Rome on November 5, 1974, against a backdrop of critical food shortages, attracted delegates from 141 countries and representatives of many private organizations. Discussions at the conference centered on the causes of the crisis and on the responsibilities of food-surplus countries and petroleum-rich nations toward those in need.

At the end of 2 weeks, the delegates agreed on a framework for concerted international action on food. They took the first steps to establish an Agricultural Development Fund, set targets for food aid, endorsed an effort to create a worldwide network of national grain reserves, strengthened the international food monitoring system, and created a small, high-level World Food Council to follow up on conference recommendations.

The conference recommended that the UN Secretary General establish a fund to finance agricultural development in the Third World if there were enough support from OPEC and developed nations. It also formed a Consultative Group on Food Production and Investment in Developing Countries, composed of aid donors and representatives of the countries in need of financial and technical aid.

Delegates reached agreement on food aid, the major exporting countries accepting a target of 10 million tons per year for the next 3 years. The conference endorsed the principle of rebuilding grain reserves and agreed that they would be held in national stockpiles rather than in an international reserve; the size of the stockpiles and their location were to be decided at later international meetings. The conference also adopted some 22 resolutions and a Declaration on the Eradication of Hunger and Malnutrition, which proclaimed the "inalienable right" of every man, woman, and child "to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties." [77]

Several resolutions referred to the quality of the environment and the need for good environmental practices. Included was this statement: "To assure the proper conservation of natural resources being utilized or utilizable for food production, all countries must collaborate in order to facilitate the preservation of the environment, including the marine environment." [78]

The conference also made specific recommendations on resource availability, nutrition, research, and the role of women. Finally, it acknowledged the population-food relationship in these terms: "The increasing demand for food is related in particular to the unprecedented population growth, which has doubled the world's population in a single generation." It called for "rational population policies ensuring to couples the right to determine the number and spacing of births, freely and responsibly, in accordance with national needs within the context of an overall development strategy." [79]

The UN General Assembly endorsed the results of the World Food Conference in December 1974; implementation of its resolutions has now begun. At U.S. initiative, an ad hoc working group on grain reserves met in London in February 1975. Further meetings, possibly under the auspices of the International Wheat Council, will follow.

The World Food Council, with a membership of 36 countries, held its first meeting in June 1975. Here it was reported that 8.9 million tons of food aid had been pledged for 1975–76, more than half by the United States.[80] The other bodies created by the World Food Conference—the International Fund for Agricultural Development and the Committee on World Food Security—have also begun operation.

Meanwhile a network of agricultural research centers is continuing its work of extending the Green Revolution. Supported by an international group of donors under the aegis of the World Bank, eight centers are located in Mexico, the Philippines, Nigeria, Colombia, Peru, India, Kenya and Ethiopia. Although they share the goal of trying to extend agricultural technology to the developing countries, each has a specific mission. For example, livestock research is the specialty of the centers in Kenya and Ethiopia.[81]

The most recent achievement of the Mexican center (known by the Spanish acronym of CIMMYT) is the development of triticale, a heretofore nonfertile hybrid of wheat and rye that has now been made self-reproducing. Its great advantages are superior protein (better than wheat protein in both quantity and quality), better drought and cold tolerance, and ability to withstand more aluminum and acidity in soil than either wheat or rye. Since 1969 triticale yields have been raised from 2 or 3 tons per hectare to 9—comparable to the best yields of Green Revolution wheat. If tests now underway in 40 countries are successful, triticale will be the first entirely new cereal ever created by man.[82]

With all its successes, Dr. Borlaug of CIMMYT views the Green Revolution as a temporary measure in the face of population growth and manipulation of the environment. He sees the spurt in food output from high-yielding varieties as "buying time"—30 years perhaps, of which 7 has already been used.[83]

POPULATION

One-fourth of the people who have ever lived since prehistory are alive today. The human population reached 4 billion in 1975 and has a built-in momentum toward further population growth. Of the 2.8 billion people in less developed countries, two out of five are under 15.[84] Although world birth rates seem to be declining, the number of young people approaching childbearing age will cause world population to grow to 6.5 or 7 billion by the year 2000.[85] Even if family size were gradually reduced in the next 30 years to an average of two children, it would take humans a full century—until 2075—to attain zero population growth. By that time, world population would have risen nearly to 9.5 billion, assuming that disease and starvation did not increase the death toll.[86]

It is in the less developed countries, which contain over 70 percent of the world's people, that most of the present increase is taking place. With some exceptions, developing countries will double their populations in 25–30 years if fertility remains constant.

By contrast, the affluent developed countries are continuing to lower their birth rates and may never double their present populations. Discounting increases from immigration, East and West Germany have already reached zero population growth.[87]

The paradox that poor people with barely enough food for themselves have many children, while affluent people have fewer, is at least as old as the Industrial Revolution. There are many reasons for this seeming anomaly. Agricultural societies value sons and daughters as labor, whereas in industrial societies, numerous children make no contribution to family welfare. The education of women and the acceptability of working outside the home raise other options for females in advanced societies other than domesticity and child care. Young people pursuing education postpone marriage and childbearing.

In industrialized nations, moreover, infant mortality declines with increasing prosperity and better health practices. No longer do their citizens find it necessary to have half a dozen children to be certain that at least one son—to till the family farm and take care of his parents in their old age—will survive. In most industrial nations, social insurance supplements or even replaces the aid that children are expected to provide their parents in old age. Those developing countries which have lately made the greatest progress in slowing population growth are generally the smaller, more prosperous ones, such as Taiwan, Singapore, and Mauritius.[88]

But development by itself will not solve the population problem. The unprecedented population growth of the past quarter century stems from the success of public health measures in reducing Third World death rates; in the huge, populous, impoverished countries, sheer numbers of people make up the base for further explosive growth. These countries may never reach the point of takeoff for development without explicit measures to control the increase of population.

An example from *Mankind at the Turning Point, The Second Report to the Club of Rome* illustrates the dimensions of the problems that these countries face in trying to accommodate population growth and form capital for development at the same time. India, whose population is multiplying at an annual rate of about 2.5 percent, recently broke the 600 million mark. Such growth creates a need for new construction every day of 1,000 school rooms, 1,000 hospital wards, and 10,000 houses.[89]

Most of the world's industrial countries took 50 to 100 years to pass from an initial period of high population growth—when health improved and death rates dropped—to a stage of drastically lower rates of population increase.[90] Declines in population growth were relatively gradual in the 19th century because modern contraceptive methods were not yet in existence, death rates dropped slowly, and the New World still offered frontier lands for emigrants when population pressures at home became too great.

By contrast, in the mid-20th century change can proceed more rapidly. Japan in the early postwar era and Hong Kong, Singapore, Taiwan, and Korea more recently made remarkable reductions in birth rates in a dozen years or less.[91] Government provision of family planning services and widely available, inexpensive techniques for fertility control have been chiefly responsible.

Family planning has generally been slow to win acceptance in many developing countries, especially in Africa and South America. Tradition, religion, considerations of national pride, and resentment of advice from wealthy countries have sometimes stood in the way. But in the past decade or so, more and more nations in the developing world have come to regard high population growth as ultimately disastrous and birth control as beneficial. In 1963, only four developing nations had national family planning policies and programs. By 1973, 34 developing countries had programs in effect, and 21 others were providing some support for family planning activities.[92] The United States with its development assistance programs and the United Nations through the UN Fund for Population Activities continue to provide support for these programs.

The World Population Conference in Bucharest in August 1974—the first population conference at government level—predictably produced a great deal of ideology and rhetoric on the subject. Some delegates asserted that there is no immediate population problem, one going so far as to declare that the world could support a population of 35 billion.[93]

Despite the rhetoric, working committees were able to agree on a Plan of Action which supported slower population growth in many countries, viewing it as interrelated with socioeconomic development. Details of the plan are discussed in last year's Annual Report.[94] Like any other document emerging from an international conference, the plan was a compromise and disappointed strong advocates of a vigorous, immediate attack. Nevertheless, its adoption by acclamation of the 137 participating nations (only one, the Vatican, subsequently withheld approval) was a milestone.

Pakistan is one of 34 developing nations which offer family planning programs.

A post-Bucharest regional Consultation of Asian and Pacific nations in Bangkok, January 14–20, 1975, took a stronger position. Member nations adopted some advanced ideas expressed at the Bucharest conference and added specific national goals and target dates. Although these goals had been developed at a pre-Bucharest conference, delegates chose not to adopt them at the world conference itself.[95]

The most important advances at Bangkok were the adoption of these goals:

- Reduce birth rates by 10 per 1,000 before 1985
- Endeavor to achieve replacement levels of fertility and eventually zero population growth in 2 or 3 decades or as soon as practicable
- Establish national goals to make family planning services universally available, not later than 1985
- Emphasize distribution of contraceptives, using paramedical personnel to reach rural people and assure a continuous supply of contraceptives
- Review laws on the minimum age for marriage.

The nations attending the Bangkok conference unanimously approved these policies. China, which has her own nationwide family planning program, was the only major nation of the area to be absent.

A corresponding regional meeting of Latin American countries held in Mexico City, March 3–7, 1975, supported the Plan of Action adopted at Bucharest but emphasized that member nations should study their own population situations. The nations attending recommended increased training, research, and regional activities in the population field and more multilateral assistance in population research.

Similar meetings were held in Doha, Qatar, March 24–28, by member nations of the Economic Commission for West Asia and in Lusaka, Zambia, April 2–8 by member nations of the Economic Commission for Africa. The West Asian nations agreed to help fund demographic studies of that region and family planning in the more densely populated countries, especially Egypt. The African countries expressed less concern about overpopulation, focusing instead on the need for economic development and the use of demographic tools in development.

The nations of the Economic Commission of Europe, which includes the United States, met in Geneva July 7–11. They gave special consideration to the decreasing growth rates and changing age structures of their populations and to formulating a response to the developing countries' needs. Delegates agreed to monitor progress on the World Population Plan of Action and to keep population concerns on the agenda for future meetings.

THE OCEANS

The oceans, which cover two-thirds of the earth's surface, make it habitable. They are the primary source of water vapor, which returns to the land as rain. They moderate climate throughout the world, cool islands in the tropics, and bring warm currents to parts of the far north and south that would otherwise be frigid. They are the earth's main filtering system, first receiving our debris, then decomposing and recycling it.

The oceans furnish oxygen for the planet's atmosphere and food for its inhabitants. The world fisheries provide some 10 percent of mankind's animal protein,[96] and phytoplankton through photosynthesis produce about one-third of the world's oxygen supply.[97]

As important as the oceans are to human life, it seems irrational that mankind would abuse them. Yet abuse is common enough, and serious enough, to bring into question the future of marine ecosystems on which man depends. These abuses may be summed up in three main categories—using the ocean as a sewer, overexploiting marine resources, and polluting the oceans with oil.

The oceans serve as the ultimate sewer for a great many of the wastes that mankind generates on land. Water used in homes, farms, and factories flows into rivers and thence to the ocean, carrying pollutants along with it. Domestic sewage is the oldest and most widespread of pollutants; crankcase drippings and waste oil come from automotive engines; industry contributes oils and heavy metals; pesticides and fertilizer runoff come from farms. In addition, wastes are loaded on barges and ships and dumped directly into the ocean.

Although the ocean can purify and recycle pollutants, its capacity to do so has limits. The sheer volume of discharges can overload natural systems, and natural processes cannot readily degrade the complex chemicals that have been created by modern industry. The more or less enclosed seas, such as the Baltic and some parts of the Mediterranean and Caribbean, are especially vulnerable.

Many but not all nations have domestic laws and regulations dealing with waste disposal in rivers and offshore waters; these standards vary in stringency and sometimes are not adequately enforced. International law has only recently begun to focus on the problem of the ocean as a waste receptacle.

The 1972 ocean dumping convention was the first response to that problem on a global scale.[98] The convention prohibits any dumping at sea of extremely hazardous substances (such as mercury and high-level radioactive wastes) except in emergency situations, it requires a special permit issued by a national authority for the dumping of other hazardous substances (such as arsenic and lead), and it provides that other materials may be dumped only with a general permit after certain criteria have been considered. In mid-1975, 54 nations had signed the convention; it entered into force on August 30 with 15 ratifications.

The ocean dumping convention will not be legally binding on nations that do not ratify it. But the Third United Nations Conference on the Law of the Sea, which completed its second substantive session at Geneva in May 1975 and will reconvene early in 1976, is considering measures that would buttress the convention and make its standards generally applicable. One provision under consideration would require all nations to make their regulations on ocean dumping "no less effective" than the global standards. Proposed measures on ocean dumping are contained in a draft Law of the Sea Chapter on Marine Pollution, prepared in May by the chairman of the conference committee considering environmental issues.[99] We will refer to it as the "Chairman's Negotiating Text."

The Chairman's Negotiating Text would also authorize coastal nations to regulate all dumping regardless of vessel nationality within a certain distance of their coasts. The text does not specify the distance; the two proposals before the conference are 200 nautical miles or, alternatively, the edge of the continental shelf where it extends beyond the 200 miles.

The convention deals with just one aspect of the problem of the ocean as sewer—direct dumping of wastes into the sea. Pollution of the marine environment from land-based discharges into streams and rivers is a much more difficult problem to handle on an international basis. The Chairman's Negotiating Text requires states to establish national laws and regulations to control their land-based pollution and calls upon them to establish global standards to that end. But although the global standards would have to be "taken into account" at the national level, they would not be legally binding.[100] At least in the near term, regional (as opposed to global) agreements may be the most promising means of developing detailed international measures to deal with land-based marine pollution. The European nations have recently made progress in this area, for example, the Paris Convention for the Prevention of Pollution from Land-Based Sources, concluded in June 1974.[101]

Even where specific international agreements are lacking, rising environmental awareness is a force to be considered. An excellent example is the Finnish arsenic dumping affair.

In March 1975, the Finnish State Oil Corporation proposed to dump 7 tons of arsenic wastes in the South Atlantic between Brazil and Africa. Ironically, the proposal was made public just before a meeting of the Baltic Marine Environment Agreement signatory nations. This agreement, to which Finland is a party, is designed to clean up pollution in the Baltic Sea.

The Finns initially held that the amount of arsenic that they planned to dump in the South Atlantic posed no ecological threat and did not violate the 1972 ocean dumping convention—which in any case was not yet in effect. Argentina and Brazil immediately protested to the Finnish government and called for a special meeting of the Organization of American States. The Finnish government withdrew permission for the dumping operation, stating that it would have contradicted the aims if not the letter of the ocean dumping convention.[102]

The strong reaction to the Finnish proposal and regional efforts to control dumping, such as the UN-sponsored Working Group on Protection of the Mediterranean, reflect a growing willingness on the international level to attack these problems. These efforts are discussed further in the Fifth Annual Report.[103]

EXPLOITATION OF MARINE RESOURCES

Man has always exploited the oceans for his own purposes. Fishing, shellfishing, and whaling for food and oil are the most obvious uses. Drying seawater for salt is perhaps the earliest example of mineral extraction from the oceans. As technology developed, fish catches increased. At the same time, more minerals were extracted from seawater and more were mined from the ocean bed.

The history of whaling is a story of recurrent overexploitation and depletion. The Basque enterprise of hunting the right whale in the Bay of Biscay flourished in the Middle Ages but had declined by the 1600's. The Greenland whale lasted for 3 centuries, until the last Dundee whaler came home empty in 1913. The great New England sperm whale hunt of the 18th and 19th centuries—ultimately put out of business by petroleum—may have been the only old-style whaling venture that did not end through overfishing.

Noticeable depletion of finfish is more recent. Around 1900 a decline in commercial fisheries attracted attention in the northeastern Atlantic after progressive mechanization of fishing. Modern fishing and whaling techniques have threatened fish and whale populations from time to time throughout the 20th century. World War II allowed some respite, permitting the populations to recover somewhat from earlier exploitation.

After the war, newly equipped fleets took up where they had left off in 1939. For nearly 25 years catches of finfish increased—indeed, increased dramatically. But first whales and then finfish soon showed the effects of overexploitation. The number of huge blue whales of the Antarctic, for example, had declined from an estimated 100,000 in 1934 to fewer than 32,000 in 1942. After a brief partial recovery during World War II, blue whale stocks were reduced to 4,400 by 1958; the present population is estimated at 5,000–10,000.[104]

U.S.-led efforts to bring about a 10-year moratorium on whaling, first proposed in 1972, have not yet been accepted by the International Whaling Commission (IWC). In 1974 and 1975, however, Japan and the USSR—the two remaining major whaling nations—agreed to other conservation measures. They include moratoriums when whale stocks fall below certain optimum levels, agreements to manage whales on the basis of stocks, and lower quotas for certain species.[105] (See the discussion in our last Annual Report.)

At its June 1975 meeting the IWC adopted a new management procedure that is a major step forward for whale conservation. It redefines "depletion" so that moratoriums will go into effect at higher levels of whale stocks and sets stricter limits for quotas. Under its terms, fin whales, with minor exceptions, may not be taken at all in the 1975–76 whaling season. The permitted whale catch is expected to decline from over 41,000 in 1974–75 to less than 33,000 in 1975–76.[106] Japan's Prime Minister Takeo Miki has pledged that his country will abide "without any reservations" with the new management procedure of the IWC.[107]

The world harvest of finfish, reflecting more nations fishing, more boats, and more efficient fishing technology, jumped from 21 million tons in 1950 to 64 million tons in 1970. Afterward the catch declined; by 1973 it had dropped to 59 million tons. A 25-year trend of steadily increasing catches has reversed.[108]

Taking pollock on a Japanese factory ship in the Bering Sea is typical of intensive worldwide fishing efforts.

The decline of certain species has been dramatic. The Atlantic bluefin tuna catch fell from nearly 40,000 metric tons in 1964–65 to about 13,000 metric tons in 1973, with larger drops in some areas. Concern for the species has led the International Commission for the Conservation of Atlantic Tunas to recommend a minimum size for tuna that may be taken and a 1-year limit on the catch to no more than recent levels.[109] Other international bodies, like the International Commission for the Northwest Atlantic Fisheries, are responsible for given species or for given fishing areas.

The living resources section of Chapter 3 contains further discussion of protection of fisheries, with special attention to the concept of maximum sustainable yield.

Mineral Resources

Exploiting minerals is not in the same class environmentally as exploiting a living, self-regenerating resource. Mining may proceed at a faster or slower pace, with more or less care for environmental consequences. But it is a one-way street. It is not a perpetual source of sustenance for man, as fishing can be if properly managed.

So far the extraction of minerals—salt, magnesium, and other chemicals—from seawater has had no more than local environmental effects. The oceans at large appear to be in no immediate danger from this activity. Taking minerals from the seabed under the water is more damaging to the environment.

Nearly one-quarter of the world's proved oil and gas reserves is offshore.[110] For resources other than oil, undersea mining takes two forms. One is the exploitation of mineral seams extending seaward from adjacent deposits on land. This form of mining has not gone beyond territorial waters. Although local effects from dredging for sand, gravel, oyster shells, tin, and other valuable deposits in coastal waters may be considerable, they are of little consequence globally. The other form of undersea mining is for deep seabed nodules which are rich in manganese, copper, cobalt, and nickel.

Among the important questions presented to the Conference on the Law of the Sea were the ownership of exploitation rights on valuable deposits and protection of the environment from possible ill effects of seabed mining. With regard to the latter, the conference reached general agreement on the need to establish an international body with power to set and enforce environmental standards for deep seabed mining.

Exploration and exploitation rights, on the other hand, triggered controversy. At one pole, many developing nations argued that the deep seabeds should be exploited exclusively by an international authority for the common benefit of all. At the other pole, nations with the expertise and technology for exploiting deepsea nodules contended that they should be able to extract the minerals under an international regime immediately and make them available to the world market.

The question is being debated. Potential environmental problems should be thoroughly studied before any large-scale exploitation begins. Mining will inevitably disturb benthic organisms. Raising the nodules to the surface will bring these organisms and possibly bottom waters as well to the surface. The effects of these unprecedented changes are uncertain. Advance experiments on a small scale may point out the possible dangers and suggest ways to deal with them.

OIL POLLUTION

Oil pollution of the oceans is a matter of serious international concern, and the potential for trouble increases as world trade in oil grows. Agreement on questions of oil pollution and the marine environment hardly goes beyond this statement.

Present knowledge of how oil affects the sea and the living creatures within it is limited, uncertain, and subject to serious differences of scientific opinion. Uncertainty begins, in fact, with just how much oil mankind spills and dumps. Estimates vary from less than 2 million metric tons per year to over 10 million.[111]

Two of the more generally accepted estimates put the annual total volume at about 5 million metric tons, which is a small fraction (0.2 percent) of the world's annual oil production.[112] It is nevertheless a large quantity. The biggest accidental spill on record resulted from the breakup of the supertanker *Torrey Canyon* off Cornwall. The ship spilled all her cargo—120,000 tons—fouling 250 miles of English and French seacoast. It would take more than 40 *Torrey Canyon* spills to equal the estimated volume of oil pollution each year.

Added to the oil that man pours directly into the oceans is indirect pollution from the atmosphere, petroleum hydrocarbons which wind and rain collect from the air and deposit on the surface of the seas. Quantitative estimates of this fallout vary enormously. One estimate shown in Table 1 is 600,000 metric tons per year; the other gives a range of 9 million to 90 million!

Aside from this indirect pollution, it appears that about one-half the oil runs off the land. This oil is refuse: discarded crankcase oil plus other oily wastes from industrial machinery, refineries, and city trash. Shipping, especially tanker traffic, is responsible for most of the rest. A relatively small share is caused by offshore oil wells.

Reliability of Source Estimates

A certain caution is in order with even the best oil pollution estimates. It is somewhat misleading, for example, to lump together oil that runs off the land with oil spilled at sea. Crankcase and industrial machinery oil, which enters sewers, creeks, and rivers inland, has weathered by the time that it reaches the sea. It is chemically different and less toxic than oil in a fresh spill and represents just one part—perhaps not the most important part—of total land-based pollution, which includes heavy metals, sewage, pesticides, fertilizer, and so on.

As for offshore oil production, the National Academy of Sciences figures shown in Table 1 are drawn primarily from experience in the tranquil waters of the Gulf of Mexico, the Persian Gulf, and the Caribbean Sea. Production experience in the stormy North Sea may change the picture. So might oil operations in still untried areas, like the Gulf of Alaska with its high winds, towering seas, and frequent earthquakes. Further, pollution from offshore oil development may rise with the volume produced offshore. At this point, however, offshore operations account for only a small share of the oil in the oceans.

Shipping is a major source of oil pollution. Here again the figures are uncertain. A widely used procedure devised to reduce intentional discharges from tankers is load-on-top. However, it is questionable whether load-on-top is as effective as the estimates assume. Load-on-top works only on fairly long voyages, requires calm seas, and demands careful supervision. Illegal oil discharges, another source of pollution, appear to escape the compilations.

Accidental Spills

Spectacular accidents like the *Torrey Canyon* breakup and the Santa Barbara offshore well blowout are the most noticeable oil pollution events, but they amount to a relatively small share of total oil pollution. Routine operations (largely emptying ballast and bilge) account for four or five times more oil pollution than ship casualties. This is not to say that major accidents are negligible. They can do

Table 1

Oil Pollution of the World's Waters

(In millions of metric tons per year)

National Academy of Sciences		Kash, et al.	
Source	Volume	Source	Volume
Marine operations	2.13	Marine operations	2.3
LOT tankers[1]	0.31	LOT tankers (ballast cleaning)	0.27
Non-LOT tankers	0.77	Non-LOT tankers (ballast cleaning)	0.70
Bilges bunkering	0.5	Discharges (bilge, pumping, leaks, etc.)	
Terminal operations	0.003	Tankers and tank barges	0.12
Dry docking	0.25	Other vessels	0.60
Tanker accidents	0.2	Terminal operations	0.09
Nontanker accidents	0.1	Tanker and tank barge casualties	0.27
Nonmarine operations	2.7	All other vessel casualties	0.25
Coastal refineries	0.2	Nonmarine operations	2.5
Coastal, nonrefining, industrial wastes	0.3	Refineries and petrochemical plants	0.30
Coastal municipal wastes	0.3	Industrial machinery	0.75
Urban runoff	0.3	Highway motor vehicles	1.44
River runoff	1.6	Offshore production	0.20
Offshore production	0.08	Normal operations	0.10
Total direct pollution	4.91	Blowouts and accidents	0.10
Natural seeps	0.6	Total direct pollution	5.0
Atmosphere	0.6	Natural seeps	[2] ≪ 0.1
Total	6.11	Atmosphere	9.0–90.0
		Total	14.0–95.0

[1] LOT means load-on-top.
[2] ≪ means very much less than.

Sources: National Academy of Sciences, *Petroleum in the Marine Environment* (Washington, 1975); Don E. Kash, et al., *Energy under the Oceans: A Technology Assessment of Outer Continental Shelf Oil and Gas Operations*, Appendix B (Norman, Oklahoma: University of Oklahoma Press, 1973). (Figures have been converted from barrels to metric tons and slightly rearranged.)

much damage locally, to beaches, to sensitive estuaries, and to many forms of marine life. The main question that divides students of the subject is whether the damage is short-lived and rather readily reversible or whether marine ecosystems recover only slowly and incompletely from massive oil spills.

It is well-established that a spill in a confined area can cause extensive damage to flora and fauna. Birds, the most obvious victims, die in large numbers from the effects of oil spills. If they ingest oil in preening, they may be poisoned; moreover, a coating of oil removes their natural insulation and buoyancy so that they freeze or drown.

Oil spills near shore, where sea life is most abundant, are particularly damaging—especially if oil remains in the sediments of wetlands and estuaries, whose great biological productivity is a chief support of the world fisheries. (See the coastal zone section in Chapter 2 for discussion of the value of wetlands and estuaries.) Oil in nearshore spills is likely to be fresh and thus more harmful; as time passes, some of the most toxic components of spilled oil evaporate or dissolve in the water.

The majority of accidental spills do occur near shore.[113] A case in point is the 210,000-ton supertanker *Metula*, which ran aground in August 1974, 1 or 2 miles offshore in the Strait of Magellan and ultimately spilled more than 50,000 tons of crude oil. Shortly after the spill, a British natural scientist commissioned by Shell Oil (which had the *Metula* under lease), reported that affected beaches were "naturally impoverished," that most of the oil would be flushed out of the Strait into the South Atlantic and that the spill appeared to be of "relatively small ecological and economic importance." [114]

Volunteers hip-deep in oil are attempting to clean up San Francisco Bay after a tanker collision.

Because the Strait's climate resembles that of southern Alaska, where the Trans-Alaska Pipeline terminus is being built, the Coast Guard and the Environmental Protection Agency were interested in the environmental impacts of the spill. At the request of the Coast Guard, a Texas A&M University scientist visited the scene. He found "massive beach deposits of oil-water emulsion, some of which was well above the highest water level." "Most of the oil that had not either evaporated or dissolved had apparently gone ashore," and there was "an appreciable bird kill." [115]

Six months later, in January 1975, a team of scientists examining the spill site found oil remaining on 100 miles of beach. They reported deposits of exposed oil on the shores up to 20 meters broad, oil blown above the shoreline by the winds, and tidal inlets heavily contaminated with oil—in some places 2 feet deep. One member of the team, an EPA marine biologist, predicted that oil would be visible in the area for the next 10 years and that traces would persist for over 50 years.[116]

In the months after the *Metula* spill, there followed an extraordinary series of oil spill accidents, nearly all of them in coastal waters or estuaries. Two sizable spills—2,600 tons in October 1974 and 430 tons in January 1975—at the modern deepwater port in Ireland's scenic Bantry Bay fouled miles of beach and destroyed marine life on the southern shore. Also in January, the supertanker *Showa Maru* hit a rock in the Strait of Malacca, spilling 3,000 tons of oil in the coastal waters near Singapore. Again in January, a freighter rammed the tanker *Corinthos* in Delaware Bay at Marcus Hook, Pennsylvania, causing a raging fire, explosions, several deaths, and an oil spill of 20,000 tons in the bay. And at the end of that same month, the 88,000-ton *Jacob Maersk* struck a sandbar and exploded while trying to enter the harbor at Oporto, Portugal. It sank in shallow water, to become a "superseeper," slowly emitting its cargo of oil and polluting 20 miles of Portugal's beach. In March, over 10,000 tons of crude oil spilled from the tanker *Tarik Ibn Zayid* in Rio de Janeiro's famous harbor.[117]

A complete record of worldwide oil spills since mid-1974 has yet to be collected, but a partial compilation by the Smithonsian Institution's Center for Short-Lived Phenomena shows that tankers of 80,000 deadweight tons spilled as much oil between July 1974 and April 1975 as ships of similar size had spilled in the 5 years 1969 through 1973.[118]

Despite extensive study of these large spills, there is little consensus on whether the damage that they cause is lasting and serious.

Chronic Oil Pollution

Scientific understanding of the consequences of persistent low-level pollution is even more limited. The effect of chronic oil ingestion on phytoplankton, for example, is a question of great ecological importance. Phytoplankton form the foundation of the ocean's food chain;

through photosynthesis, these organisms—analogous to plants on land—generate 90 percent of the living material of the sea and oxygen for the oceans' ecosystems as well.[119]

It is well-established that much of the ocean's plankton has been contaminated with oil. After surveying the Atlantic from Cape Cod to the Caribbean, a team of U.S. government scientists reported that more than one-half the plankton samples that they collected contained oil.[120]

What is the effect of this contamination? The answer is uncertain. In dilute concentrations, that is, below 10–30 parts per billion of seawater, oil actually appears to speed photosynthesis in phytoplankton. But in higher concentrations (60–200 parts per billion), both refined and crude oils definitely hamper photosynthesis. This whole range of oil solutions is typical of those in polluted coastal areas and near spills.[121]

The effect of chronic oil pollution on offshore fisheries is likewise uncertain. We do know that persistent oil contamination damages wetlands and estuaries, destroying grasses and eroding the banks of salt marshes.[122] It endangers fish eggs and larvae, which may die if exposed to oil solutions as low as 0.1 parts per million.[123] There is some evidence that it is a particular threat to bottom-dwelling creatures, especially sedentary ones like clams and oysters that cannot readily move away from oil pollution.[124]

Overall, the effects of persistent pollution may be greater than those of a massive spill. Suggested low-level effects include interference with photosynthesis and respiration; disturbance of normal patterns of feeding, schooling, reproduction, and development of the young; and possible production of cancer or genetic mutation.[125]

In our 1974 report on OCS oil and gas, we identified 17 major areas of ignorance about the effects of oil pollution.[126] The list begins with the need for baseline studies of the life histories of many marine species and embraces such other broad questions as sources of oil in the oceans and long-term effects of oil on marine organisms, commercial fisheries, and the food web. The Council did not propose that oil development cease until these questions are definitively settled, but the scope of the list underscores the necessity for caution. By the time that scientific knowledge of the effects of oil on the environment approaches certitude, serious and even irreversible harm may have taken place.

Controls on Oil Pollution

Much of the chronic nearshore oil pollution comes from runoff from the land. In the United States and many other developed countries, water quality laws are helping to control oil pollution from this source.

The maritime nations have long been concerned about chronic oil pollution of the oceans from tanker operations. The 1954 International Convention for the Prevention of Pollution of the Sea by Oil established the basic international rules on oil discharges.[127] The convention set limits for both the concentration of oil in discharges and the areas where discharges may be made.

At a 1973 conference sponsored by the InterGovernmental Maritime Consultative Organization, some 80 nations negotiated a new convention that is both broader and stricter than the 1954 treaty. The 1973 International Convention for the Prevention of Pollution from Ships applies not only to crude oil but also to refined oils, which may be more toxic to marine life than crude oil. The 1973 convention also applies to several hundred dangerous liquid cargoes other than oil, including various hazardous chemicals.[128]

This ship pollution convention forbids virtually all discharge of oily wastes by tankers within 50 miles of shore and establishes strict limits for oil discharges elsewhere; it also tightens the rules for ships other than tankers. It requires that new tankers over 70,000 deadweight tons be fitted with segregated tanks for ballast, and it also requires automatic monitoring devices to make sure that ships' crews observe the rules on discharges.

The agreement will not take effect until at least 15 nations ratify it—with the further proviso that the ratifications must cover one-half the gross tonnage of the world's merchant fleet. This process may take several years; the 1954 convention was not fully ratified until 1962. As of mid-1975, 16 nations (including the United States) had signed the convention, but none of these had ratified it.

The Conference on the Law of the Sea is considering the question of jurisdiction to enforce the international vessel pollution standards. The conference is looking at the option of allowing the "port" nation where a ship calls to enforce international standards against an offending ship regardless of whether the offense occurred in that nation's waters or elsewhere. Another proposal is that coastal nations be allowed to enforce the international rules within an agreed-upon distance of their coasts.[129] The distance is still to be settled; proposals range from 12 to 200 miles.

The 1973 convention on ship pollution is aimed chiefly at controlling routine discharges and chronic pollution, but its requirements for segregated ballast could help limit accidental oil spills as well. The Coast Guard is looking into the design of segregated ballast tanks to protect against oil spills in case ships collide or run aground.

Another defense against oil spills is a fast, effective response when a tanker is in trouble. There are two related elements involved—an institutional mechanism and the physical capability to transfer oil from a disabled tanker before it spills and to clean up the oil that does spill.

At present there is no international mechanism to deal with oil spills. IMCO is passive; it simply receives spill reports. Its new Marine Environment Protection Committee, created in 1973, may develop in the direction of organizing contingency plans to meet oil spill emergencies in all regions of the world. The Chairman's Nego-

Shipping is a major source of oil pollution. Routine discharges from tankers will be better controlled when the 1973 ship pollution convention takes effect.

tiating Text for the Law of the Sea Conference would oblige nations to develop joint contingency plans.[130]

Not only are the contingency plans lacking; so is the physical equipment to deal with accidents. The National Strike Force of the U.S. Coast Guard is well-equipped to pump oil from supertankers in distress. Canada, with a smaller capability, works with the United States in emergencies, as does New Zealand. Several private salvage firms are adding to their pumping equipment, but altogether their capability is still far short of the Coast Guard's.

The *Metula* incident illustrates some of the problems. The grounding was in a remote area. Neither the Chilean government nor Shell was prepared for it. Although the private salvor called to the scene is the world's largest, additional equipment from the Coast Guard's strike force was needed to offload the huge tanker and forestall the possibility of a larger spill. Even so, when tugs arrived to maneuver the *Metula* and smaller tankers to take on the remains of her cargo, the supertanker had ruptured a second time. The first leak spilled 10,000 tons; the second, 10 days later, 40,000.

The *Showa Maru* is a somewhat similar case. The spill occurred off the modern port of Singapore; nevertheless, private salvors lacked enough equipment to transfer *Showa Maru's* oil, and the Coast Guard strike force was again called in.

No attempt was made to clean up the *Metula* spill in wild, remote Tierra del Fuego, but if the Chilean government had decided to try, the effort would have been severely limited by lack of equipment. According to scientists who evaluated the *Metula* spill, it would take 12,000 dump truckloads to remove the oil from the beaches.[131]

As international efforts to respond to tanker accidents improve, oil spills may be handled more successfully. But prevention is of course the best cure. The U.S. Coast Guard emphasizes training of ships' officers and crews as a most important measure to avert tanker accidents. Better control of ship traffic in harbors and their approaches is another significant factor, as is improvement of tanker design and construction.[132]

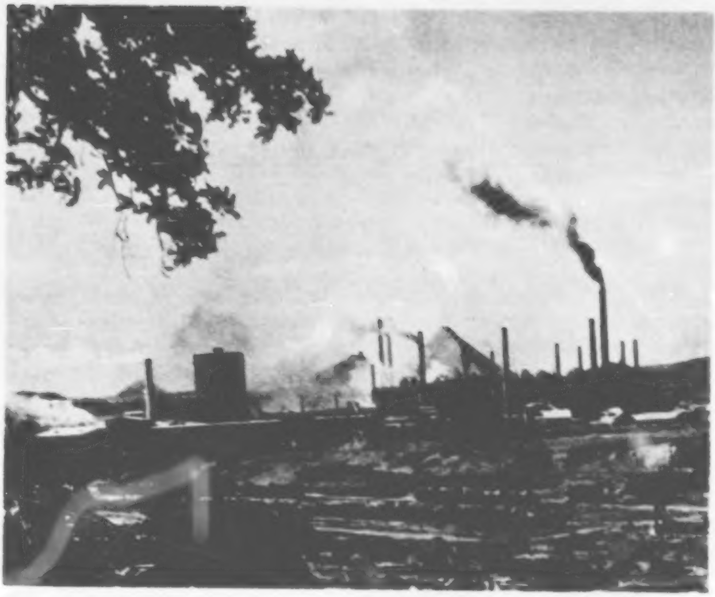
Engineering improvements to make unwieldy supertankers more maneuverable—twin screws, twin rudders, bow thrusters, greater backing power, controllable pitch propellers—have been urged for tanker safety.[133] The U.S. Coast Guard, however, does not believe that improving maneuverability would result in less pollution. There is general agreement that deepwater ports that keep supertankers out of crowded harbors (as with an offshore monobuoy port, for example) would be desirable.[134]

Finally, more oil shipped in world trade means more occasions for oil pollution in the seas. Any measures that the big oil-consuming countries take to practice energy conservation and limit growth in oil demand will also tend to relieve oil pollution. Development of alternative energy sources would have the same effect.

ECONOMIC ASPECTS OF ENVIRONMENTAL POLICY

Developed and developing countries of the world see their environmental problems differently.[135] Developed countries tend to be most concerned about reducing or eliminating pollution, man's threat to wildlife, the aesthetics of sprawl, and the costs of environmental degradation to man's health and quality of life.

For the developing countries, on the other hand, the principal aspect of environmental degradation is poverty, caused by lack of development rather than abuses of it. Moreover, the developing countries frequently view their poverty as the result of exploitation by the affluent nations, going back to the centuries of colonial rule.



Pollution from industry is a major concern of developed nations. In developing countries, poverty is seen as the principal environmental problem.

Thus is the stage set for conflict between the two. The economic costs of environmental control have until now almost entirely overridden any serious concern for pollution abatement in the developing nations of the world. These nations, in fact, have appeared willing to accept pollution as a necessary cost of development—even to insist on the right to pollute, on the ground that the developed nations did so during their period of industrialization.

DEVELOPED COUNTRIES

During the 1960's the developed countries became increasingly concerned over the environmental damage which accompanied economic growth. An important international issue is how the costs of abating this damage are to be paid. The industry responsible for pollution may be required to pay abatement costs, either absorbing them or passing them on to consumers in the form of higher prices, or governments may subsidize the extra costs in whole or in part. The difficulty is that industries in countries with government subsidies may gain a competitive advantage in world trade.

In response to concern over this difficulty, member nations of the Organization for Economic Cooperation and Development—OECD includes all the industrialized Western nations and Japan—in 1972 subscribed to a "Polluter Pays Principle," which states that the industry or other source that pollutes must pay the costs of abatement.[136]

The principle recognized the possible need for exceptions or special arrangements, such as government subsidies, particularly for transitional periods, provided that they do not lead to significant distortions in international trade. In order to clarify exceptions on government subsidies, the OECD resolved in 1974 that government assistance could be granted only under the following circumstances:

- When a necessary but especially stringent pollution control regime may result in significant socioeconomic problems
- When the purpose of the subsidy is to stimulate experimentation with new control technologies
- When a subsidy is intended to promote specific socioeconomic objectives, such as correcting interregional imbalances.[137]

Further, the OECD countries agreed that any exceptions must be restricted to those sectors of the economy where severe difficulties would otherwise occur.

The Council of the European Communities accepted the Polluter Pays Principle in 1973, also recognizing the possible need for government assistance for transitional periods provided no significant distortion to international trade and investment results.[138] In detailed rules governing application of the principle, exceptions were justified when serious economic disturbance or greater social costs might result from imposed pollution control measures. The council made clear European Communities policy that any measures taken would apply only to existing production plants and existing products.[139] A list of criteria for government subsidies to help cover the costs of imposed pollution controls to existing plants was developed specifying the proportion of such costs that a government may pay and setting a timetable for phasing down any subsidies.[140]

The Polluter Pays Principle was not adopted to improve international environmental quality per se. Deviation from a strict application of the principle may in fact improve environmental quality, although at the same time it may raise basic economic issues of efficient allocation of resources. If industry meets with substantial difficulty in adapting its current plant to new regulations, a flat prohibition against government assistance may work against national goals of environmental improvement. On the other hand, full cost pricing of pollution abatement costs does make pollution-intensive manufacturing more expensive and in effect encourages the consumption of goods that generate less pollution.

The Commerce Department reports each year on the advantages that may accrue to foreign manufacturers if U.S. firms are required to incur pollution control costs that are not required of their foreign competitors. The third of these reports, dated April 1975, analyzes pollution control costs in the kraft woodpulp, copper smelting, phosphate fertilizer, and aluminum reduction industries. After noting the difficulty of acquiring reliable data on pollution control costs and international prices, the report concludes that to date no identifiable changes in trade and investment patterns have resulted from pollution control cost differentials. Further, no OECD nation has requested consultations with another in accordance with established procedures for discussing alleged violations of the Polluter Pays Principle.[141]

DEVELOPING COUNTRIES

Even before the 1972 UN Conference on the Human Environment in Stockholm, the developing countries were defensive about environmental concern as defined by the industrialized states. Indeed, the sensitive relationship between development and environment was the subject of a special pre-Stockholm meeting of 27 experts, at Founex, Switzerland, in 1971. In the subsequent Founex Report, Maurice Strong, Secretary-General of the Stockholm Conference, pointed out that "environment" had only recently become a global issue which "first arose in the highly industrialized societies in which concern centered on the adverse consequences of many of the varied practices and technologies which have produced the unprecedented affluence of those societies." "In this context," he added, "it is not surprising that many people in the developing countries questioned the relevance of this new concern for environment to their own compellingly urgent development priorities." [142]

The developing nations, quite logically, interpret "environment" in terms of their own problems. They see poverty, lack of development, poor water, substandard housing, sickness, disease, and malnutrition as the principal threats to "quality of life." According to the Founex Report, the basic cure for these major environmental problems is economic development.

The report recognized that economic development had already produced environmental problems in the poorer nations, problems that would likely be intensified as further industrialization proceeds. Even so, the report expressed a concern that environmental action by developed countries might retard economic growth in developing countries.[143]

The developing nations do not bind themselves to the Polluter Pays Principle. Generally they impose minimal pollution control requirements on industry and have little resources to enforce the restrictions. They fear that they may have to pay for pollution control in developed countries through higher prices on imports and that markets for their exports will be reduced by stricter environmental standards in the importing countries.[144]

The developed countries, on the other hand, have been concerned that industries facing increased costs may shift to so-called "pollution havens" in developing countries with less stringent environmental standards. In 1971, as the Founex Report indicates, some developing countries saw an opportunity for economic growth in welcoming industries fleeing tough pollution controls.[145] As discussed in the economics chapter, so far there has been no such flight.[146]

The theme of the Founex Report was repeated at the Stockholm conference in a number of resolutions emphasizing the concern of the developing countries over their lag in development.[147] In the years since the resolutions were adopted, demands of the poor nations for help in economic development have—to many ears in the developed world—taken on an unreasonable, even menacing tone. Encouraged by the success of the oil-producing countries in raising petroleum prices and by their own overwhelming majority in the UN, the developing nations have asserted claims for a larger share of world resources in several recent documents: the Declaration on the Establishment of a New International Economic Order,[148] the Programme of Action on the Establishment of a New International Economic Order,[149] the Charter of Economic Rights and Duties of States;[150] and the "Cocoyoc Declaration."[151]

All of these documents argue that Third World poverty stems from exploitation by the developed nations, their extravagant consumption of raw materials bought from the poor countries at low prices, the historical consequences of 5 centuries of colonial control, and excessive reliance on the market system. They develop a new doctrine of "permanent sovereignty" over natural resources, which alters or even abandons currently accepted international law by asserting that "each State is entitled to exercise effective control over them (resources) and their exploitation with means suitable to its own situation, including the right to nationalization or transfer of ownership to its nationals."[182]

This stand was modified later, in the Charter of Economic Rights and Duties of States, with inclusion of the clause "appropriate compensation should be paid by the State adopting such measures." But even that charter insists: "In any case where the question of sovereignty gives rise to a controversy, it shall be settled under the domestic law of the nationalizing state . . . unless it is freely and mutually agreed by all States concerned that other peaceful means be sought . . . ."[183] This provision, predictably, has drawn sharp reaction from the developed world.

The October 1974 Cocoyoc Declaration epitomizes the frustrations of the less-developed world. It goes much beyond the 1972 Founex Report in blaming the developed world for the depressed state of the poorer nations. It begins by noting that 30 years after the signing of the UN Charter, "hopes of creating a better life for the whole human family have been largely frustrated." It questions whether in view of environmental degradation and the rising pressure of resources "the 'outer limits' of the planet's physical integrity may not be at risk."

The Cocoyoc Declaration recognizes that the world population will double in the next 30 years and that the biosphere has a finite carrying capacity. But it adds: "The problem today is not primarily one of absolute physical shortage but of economic and social maldistribution and misuse . . . ." It asserts that the world faces the anomaly of underdevelopment existing side by side with "overconsumptive types of development that violate the inner limits of man and the outer limits of nature."[184]

The Cocoyoc Declaration was prepared by UN and other international organization officials and private individuals from both developed and developing countries selected by the UN Secretariat. No representatives of government were involved. It received official recognition on December 17, 1974, when the UN General Assembly took note of it in approving a Resolution on the Report of the Governing Council of the United Nations Environment Program. This resolution also requested one of the cosponsors of the Cocoyoc Symposium, the UN Environment Program, to conduct its activities in its field of competence, in line with the Declaration and Programme of Action on the Establishment of the New International Economic Order.[185]

The Seventh Special Session of the General Assembly, held September 1–16, 1975, approved a comprehensive resolution containing an agreed approach among developed and developing countries to the problems of development and international economic cooperation. The developed nations, aware of the need to narrow the gap between themselves and the less developed world, agreed to increase development assistance and to adopt new approaches in international trade, the international monetary system, science and technology, food and agriculture, and other areas. Improvement in quality of life for the poorer peoples of the world was the objective.

For their part, the developing countries are becoming more concerned about environmental degradation as they proceed along the path of economic development. They are developing programs and institutions to protect and improve their own environments. At the same time, they are cooperating more closely with the rest of the world through bilateral and multilateral exchange for improved global environmental quality.

THE UNITED NATIONS ENVIRONMENT PROGRAM

During 1974 UNEP continued the development of its Action Plan for the Environment, begun at its first session. High priority has been given worldwide environmental assessment in its Earthwatch program. But as plans are being developed for symposia and other meetings in 1976, little progress has yet been made on guidelines for the projected Global Environmental Monitoring System and the International Information Referral System, two principal elements of Earthwatch. A third element is concerned with research on the condition of the world environment.

Among UNEP's major initiatives in the last year was the program for monitoring and cleaning up pollution in the Mediterranean Sea. Draft conventions have been prepared to further this purpose. Plans also are being developed to establish research and monitoring stations on the periphery of the Mediterranean. Similar regional efforts are expected to be launched for other international bodies of water.

The Third Session of the Governing Council of UNEP, held April 17–May 2, 1975, in Nairobi, was marked by a spirit of cooperation among all the participants and an absence of confrontation between the developed and developing countries on the council.

The council agreed upon a number of significant resolutions. One called for a review of draft principles for conservation and harmonious exploitation of natural resources shared by two or more nations. It approved additional funds to support the UN Conference on Human Settlements, called Habitat, to be held in Vancouver, Canada, in May and June 1976.

The present and future program of UNEP was discussed in detail. Concern was expressed about the direction that the program is taking and the tardy development of specific programs to accomplish the original global environmental objectives set forth at the Stockholm conference. The Governing Council meeting made progress on an effective program of activities and cooperation with other United Nations agencies with responsibilities of environmental significance.[186]

INTERNATIONAL CONSERVATION OF NATURE

Human activities that alter or destroy diversity in the global ecosystem thereby diminish its ability to recover from reverses. To safeguard genetic diversity—and the long-term survival of humankind—it is desirable to preserve as many remaining natural areas as possible in a virgin state. The "gene bank" is another means of preserving genetic resources, especially those of plants, but it is less reliable than nature. The machinery necessary for gene banks can break down, with irretrievable loss of material. For example, a major Peruvian collection of corn germ plasm was lost when three refrigeration compressors failed.[157] Green Revolution technology draws on genetic resources both from nature and from gene banks in its work of developing new plant strains by gene enhancement.

Protected natural ecosystems not only serve as a source of genetic diversity but also provide field laboratories for ecological research or the productive management of many kinds of lands. International efforts to protect natural ecosystems systematically are focused on developing a worldwide network of Biosphere Reserves through the Man and the Biosphere (MAB) program organized by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). Biosphere Reserves are designed to conserve biotic communities within natural ecosystems, safeguard genetic diversity of species, provide areas for ecological and environmental research, and provide facilities for education and training.[158]

At the Third Meeting of the International Coordinating Council of MAB, held in September 1974, the United States announced designation of 20 federally protected land areas as Biosphere Reserves. Four other countries, Austria, France, the Philippines, and the United Kingdom, have made their designations, and 13 Latin American countries announced plans to do so at a MAB regional meeting held in Mexico City in October.[159]

Previous Annual Reports have described efforts to develop international agreements relating to conservation of nature. The ratification and implementation of these conventions often take months or even years after they are negotiated and signed. It is encouraging to note that the Convention on International Trade in Endangered Species of Wild Fauna and Flora, negotiated in February 1973, has been signed by 57 nations and ratified by 16. It entered into force on July 1, 1975.[160] The International Union for the Conservation of Nature and Natural Resources will provide support functions for this convention. The formalities of adopting the convention took 2 years, but meanwhile many countries had adopted similar domestic legislation. In consequence, by mid-1975 environmental journals were carrying articles about the recovery of threatened animal populations. For example, alligator populations are recovering in several parts of the southern United States, and the vicuna population is increasing in the Andes.[161]

Alligators made a comeback following legal protection as an endangered species.

As of June 1975, the Convention on the Protection of the World Cultural and Natural Heritage—the World Heritage Trust—had been ratified by 10 nations. It will enter into effect when 20 nations ratify it.

THE POLAR REGIONS

The harshest and most untouched environments on earth are at the two poles. The poles were not reached until early in this century and exploration, particularly of Antarctica, is continuing. These regions act as the heat sink in the global thermodynamic atmosphere-ocean-land-ice system and thus are critical to the world's ecosystems. Polar air, for example, determines much of the weather in the middle latitudes on both sides of the equator. Oxygen- and nutrient-rich ocean waters from the Arctic and Antarctic are essential to many fisheries in distant parts of the world. Both polar regions may now be threatened by proposals to begin or accelerate exploitation of their living and nonliving resources.

The Arctic

Human beings have appeared in and exploited the fringes of the Arctic since prehistoric times. Until recent times, however, man's presence was minimal and generally had little impact on the environment. Overexploitation of some of the Arctic resources, primarily the whale and polar bear, has led to international agreements. An agreement to control hunting polar bears was signed by four Arctic peripheral states in 1973 but has not yet come into force.[162] The North Pacific fur seals were covered in a very early conservation agreement dating back to 1911; it has fostered a substantial recovery of this threatened population from an estimated 250,000 in 1911 to about 1.4 million today.[163] The United States has proposed a partial renegotiation of this convention to strengthen its conservation provisions and bring it into closer conformity with the Marine Mammal Protection Act of 1972.[164]

The Arctic now faces its most serious threat because of the extensive petroleum deposits discovered off Norway, Canada, and Alaska. Technology developed for the exploitation of offshore oil deposits in milder climates cannot be relied upon in the harsh environmental conditions prevailing in the far North. In the United States, the Inter-Agency Arctic Research Coordinating Committee is making the first in-depth study of the Arctic environment and is helping to develop technology suited to conditions there. The committee is also working with Canada, whose Arctic activity was a topic of discussion when Canada's Minister of the Environment visited the United States in March 1975.

The North Pacific fur seal population has increased fivefold since the international conservation agreement of 1911.

The Antarctic

The South Polar region, unlike the Arctic, is distinguished by a continental land mass, Antarctica, that rises high above sea level but lies mostly below a deep icecap. This continent is a potential source of valuable minerals. Coal deposits near the surface have been discovered in several areas, and traces of hydrocarbons, possibly indicative of oil, have been detected beneath offshore waters. These waters are also among the world's richest sources of protein. They remain a whaling ground of substantial although reduced productivity. As in the Arctic, the harsh environment is a delicate one, with a precarious ecological balance maintained in a virtually untouched area among the relatively few but abundant species of phytoplankton, zooplankton (including the as yet unexploited krill), and the fish and marine mammals up the line on the food chain.

The nations conducting scientific investigations in Antarctica in connection with the International Geophysical Year (1957–58) saw in the Antarctic a virgin area for scientific research. Out of a desire to prevent political conflict over national claims or military use of the area that would prejudice further scientific effort, they developed the Antarctic Treaty of 1959. It sets aside, without eliminating, territorial claims already made by several of the 12 participating nations, prohibits military use of the area, and dedicates it to peaceful purposes and scientific research.[168] Exploitation of the resources of the Antarc-

Exploitation of Antarctica's mineral resources may threaten the delicate ecological balance of the polar region's few but abundant species.

tic was considered premature for the treaty at that time. This question was implicitly tabled for future resolution when the time came.

That time appears to have arrived, for the minerals in Antarctica—especially offshore—are arousing interest, and the technical capability to exploit them may soon be developed. A special meeting of the Antarctic treaty powers was held in Oslo in February 1975 to discuss Antarctic resources and the possible effects of mineral exploration on the environment. At the Eighth Antarctic Treaty Consultative Meeting held in Oslo in June, participating nations approved a resolution that called for restraint in exploitation while they seek solutions to problems involving Antarctic resources.[166] The treaty powers invited the Scientific Committee on Antarctic Research of the International Council on Scientific Unions to assess the environmental impacts of mineral exploitation on the treaty area and other ecosystems dependent on the Antarctic.

International agreement already regulates the taking of native mammals and birds on the Antarctic continent.[167] Beyond that, the Convention for the Conservation of Antarctic Seals was negotiated by the 12-nation Antarctic treaty group in 1972 to regulate any future commercial hunting of the Antarctic seal in the seas south of 60° south latitude. As of August 1975, 4 of the 12 had ratified the Convention for the Conservation of Antarctic Seals was negotiated Department of State has completed the final environmental impact statement on the convention,[168] which will now be submitted to the U.S. Senate for advice and consent on ratification.

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CHAPTER 6

THE NATIONAL ENVIRONMENTAL POLICY ACT

Perhaps because of the demanding nature of the National Environmental Policy Act (NEPA),[1] the process of evaluating its effects becomes increasingly complex. Section 101 established challenging policy goals for all federal activities, and section 102 required wholly new environmental procedures of all federal agencies. Further, all sections of NEPA were couched in very general and sweeping terms without the explicit legislative history that often guides federal agencies.

The breadth of the act has, in fact, been its great strength. Since 1970, NEPA has stimulated dynamic administrative, legal, and academic thought and has charted a rapid evolution of agency compliance.

But the impact of the National Environmental Policy Act is sometimes elusive, and it is often difficult or even impossible to credit NEPA for specific agency actions. And from time to time, NEPA's goals may be overshadowed by economic and social problems. The recession of 1975, following hard on 1974's energy problem, has caused such concern, for while the environmental values inherent in NEPA remain strong, they were strenuously challenged in the past year.

This year's chapter on NEPA focuses on implementation of the act by federal agencies. In particular, it looks at the use of the NEPA process in federal agency decisionmaking, the federal efforts being made and considered to improve the content of impact statements, and the workings of the impact statement review and commenting process. The chapter addresses the question of costs and delays associated with NEPA, the number and types of environmental impact statements that have and will be required, and the time required for EIS preparation.

The legal section of this chapter focuses on two significant issues involving agency implementation of NEPA that have arisen in the courts and in the Congress this past year—the questions of when impact statements covering broad agency programs are necessary and when federal agencies may delegate EIS preparation responsibilities. This section concludes with a note on a recent Supreme Court decision and a discussion of the recent experience under NEPA with a new federal revenue sharing program.

Following the legal discussion, two additional chapter sections briefly update last year's Annual Report description of state experiences with their impact statement requirements and foreign government initiatives to apply the impact assessment concept to their own needs.

The chapter concludes with some thoughts about the current direction of NEPA and the major issues to be addressed in the future.

EVALUATION OF AGENCY NEPA COMPLIANCE

As one of its primary duties under NEPA, the Council on Environmental Quality oversees the act's implementation, including section 101 and the EIS process. Following a review of agency NEPA practices in 1971 and pursuant to Executive Order 11514,[2] the Council established Guidelines for preparation of environmental impact statements. After review 2 years later, the Guidelines were revised in August 1973.[3] In spring 1975, the Council again reviewed agency implementation after submission of a detailed questionnaire to all agencies. Council staff met with various agencies and began work with the National Governors Conference to obtain state views of the NEPA process. Many of the results of this ongoing review are reflected in this chapter.

In large measure, NEPA directs agencies to make their own environmental policy changes within the general substantive guides of section 101 and following the procedural requirements of section 102. Given this situation, agency compliance with both the goals and the procedures of NEPA varies depending on the agency's pre-NEPA statutory and/or administrative environmental mandates; the nature of the agency's programs—whether primarily grants, permits, land management, construction, or regulatory programs—and the amount of funding available to support environmental analyses and planning for such programs; the number of agency projects whose planning or construction began prior to NEPA's passage but to which NEPA was applied, requiring early and concerted agency attention; the amount of NEPA litigation experienced or perceived as likely by the agency; and most important, the attitude of the agency leadership toward NEPA and its desire to use the act as an aid to the management process.[4]

Although these factors seem to determine the extent to which an agency responds to NEPA, it is difficult to evaluate that response. One reason is that NEPA involves much more than the environmental impact statement process. Nevertheless, the EIS record is frequently perceived as the best and only external measure of the extent to which an agency complies with NEPA's other procedural requirements and seeks to implement NEPA's broad goals. It is tempting to judge an agency on the number of EIS's that it produces or by measuring their thickness. But then one would miss the environmentally sound planning procedures and decisions that were reached because of NEPA's broader effects. The influence of an EIS on an agency's decisionmaking process appears to be only a part of the more pervasive influence of NEPA.

USE OF NEPA IN DECISIONMAKING

Simply stated, NEPA requires all federal agencies to analyze the environmental effects of proposed actions and of reasonable alternatives to such actions, in addition to the agencies' traditional economic and technical analyses. The EIS is the most visible public evidence of agency environmental planning and review. When the Congress required environmental impact statements, it was because previous practice was inadequate—agencies' planning and decisionmaking procedures had ignored or misjudged significant environmental impacts and would continue to do so unless a publicly accountable document were prepared and its criticisms considered before taking a major action.

The Congressional remedy proved effective. Federal agency procedures to build NEPA into their planning and decisionmaking now affect all levels of government, from field and project planning and operating levels to agency administrator or department secretary. The resulting analysis of environmental effects and alternative proposals—and the public disclosure of such information—have proved workable and critical parts of environmental protection policies.

The EIS itself is intended to be, and often is, the tip of an iceberg, the visible evidence of an underlying planning and decisionmaking process that is usually unnoticed by the public. The EIS is not meant to be an end in itself but is to reflect ongoing analysis. Consequently, agency experience with environmental impact statements since 1970 can provide useful evidence of NEPA's effect on federal project and program decisions. The CEQ review indicates significant benefits.

For example, it is widely known that the Interior Department's EIS process on the 800-mile Trans-Alaska Pipeline prompted design changes and other improvements that participating oil companies have since found important as they proceed with construction under strict performance standards.

Interior has successfully used NEPA and the EIS process to influence its decisionmaking in numerous other situations—in eliminating certain tracts from OCS leasing, in improving coal and oil shale operating regulations, and in prohibiting jets from intruding on Grand Teton National Park. Within Interior, the EIS has intensified the planning process before preparation of a statement, improved the content of related documents, such as the decision paper that is prepared for the Secretary on major proposals, and improved coordination of planning.

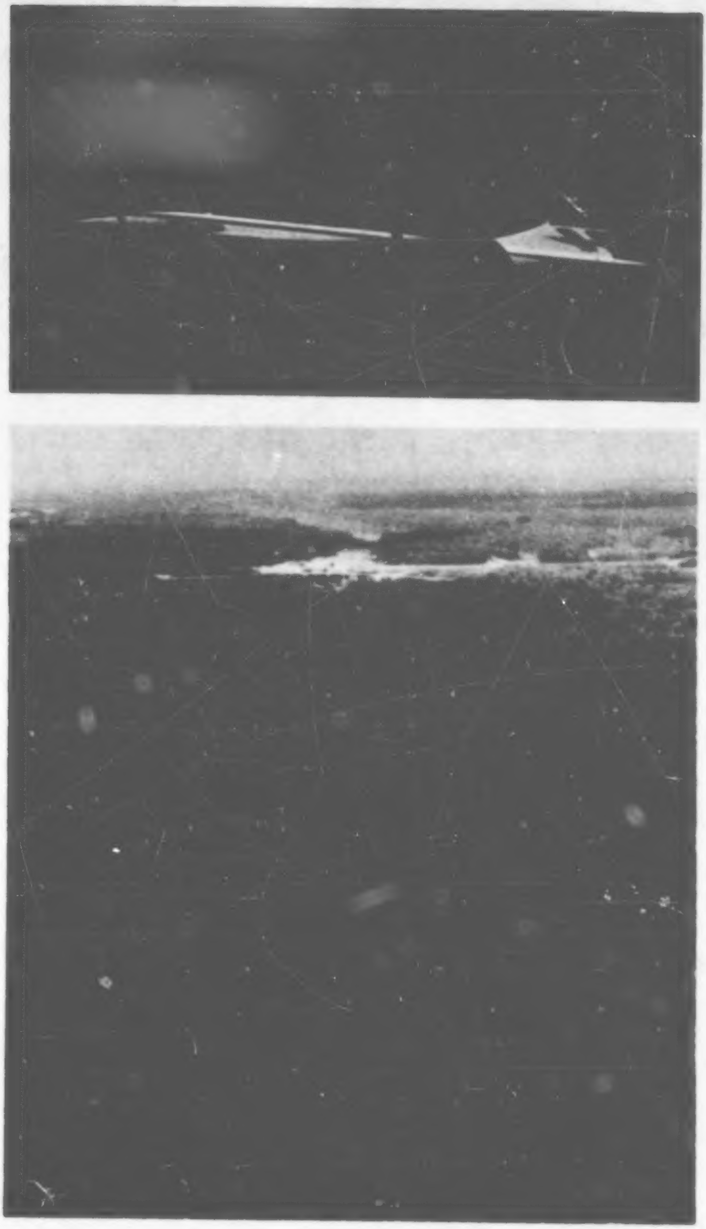
Two major radioactive waste disposal proposals of the former Atomic Energy Commission, one at Lyons, Kansas, and the other on the Savannah River in South Carolina, were abandoned because of uncertain environmental impacts identified by AEC and public analyses conducted through the agency's EIS process.

In early 1975, one of the AEC's two successor agencies, the Energy Research and Development Administration, reviewed the wide and varied criticisms of the AEC draft program statement on commercially generated radioactive waste management, which had concluded that surface storage facilities offered the best interim solution. ERDA concluded that NEPA and the public interest would be best served by another look at the problem through a new program statement and so withdrew its storage facility budget request.

The other AEC successor, the Nuclear Regulatory Commission, used the AEC impact statement on the breeder reactor and its own on the plutonium recycle proposal as definitive bases on which to develop stronger measures to safeguard against the misuse of nuclear materials. Like the former AEC, NRC's reactor licensing directorate has integrated the EIS into its licensing decisionmaking process and, as a result of this environmental work, has modified a number of project decisions.

The Corps of Engineers decided to drop or abandon work on over a dozen proposed projects because its NEPA process revealed that significant environmental damage would result. Eleven other projects have been stopped until environmental analysis is complete. The Corps has also modified many more due in large part to NEPA and the EIS requirement. These actions have resulted in widespread, but unquantifiable, environmental benefits.

Similarly, the Department of Transportation uses NEPA and the EIS process to examine large numbers of highway and airport proposals, many of which would have important effects on urban and rural land use. DOT estimates that since 1970, scores of major projects have been abandoned or changed as a result of the EIS process and a determination to avoid adverse effects. Again, it is difficult to calculate the social benefits, but we do know that the resources saved can be used for transportation projects that analysis proves worthy of the taxpayer's money.



Illustrating the scope of NEPA are the FAA environmental impact statement on proposed daily Concorde flights and the Corps of Engineers study of the proposed Cross-Florida Barge Canal on the Oklawaha River, before preparing an EIS.

Within the Department of Defense, environmental impact statements have influenced a number of project decisions in addition to those of the Corps. For example, the Air Force used the NEPA process at Eglin Air Force Base to incorporate federal, state, and local recommendations into a military housing development and preserve existing natural and cultural resources. Similarly, the Navy changed the location of its Atlantic Combat Maneuvering Range due to possible adverse environmental effects. The Army has used the EIS process to modify a number of demilitarization projects.

The EIS process has also affected building projects of the General Services Administration. In 1974 when the Kennedy Library Corporation proposed construction of the Kennedy Library and Museum just below Harvard Square, GSA, which was to build and maintain the structure, issued a draft EIS. It focused attention on the traffic and other adverse effects on the area. As a result, the Library Corporation decided against the proposed museum site and is examining several other alternatives while planning to keep the Kennedy archives on Harvard University property.

The environmental analysis, of course, involves much more than preparation of a draft or a final document. For many agencies, such as the Soil Conservation Service of the Department of Agriculture, the major influence of section 102(2)(C) is felt before a draft is prepared, when the agency conducts environmental evaluations or assessments,

A GSA impact statement on the proposed Kennedy Library and Museum below Harvard Square, at the point indicated by the arrow, focused attention on adverse impacts of the plan.

partly to determine whether an EIS is necessary. The SCS has successfully used preliminary draft EIS's to broaden the scope of project alternatives, particularly those involving nonstructural measures.

The Department of Housing and Urban Development carried out its own NEPA review, noting the effect of pre-EIS environmental analysis on HUD decisionmaking in over 150 situations. HUD reported that "environmental impact assessment procedures have lead to the elimination of projects with adverse environmental impacts prior to formal (EIS) processing. All regions report that developers are much more aware of environmental quality and that [as a result] proposed sites are often environmentally more sound." [8]

Over the past several years the NEPA process has had an increasingly significant effect on the extensive land use planning efforts of both the National Park Service and the Forest Service. Environmental assessments and statements have been used routinely by both agencies to evaluate and present to decisionmakers the impacts of various plans and alternatives for the use of National Parks and Forests.

Perhaps the most far-reaching use of the EIS process has been the work of the Forest Service to develop a long-range program for forest lands pursuant to the Resources Planning Act of 1974.[9] As part of its program development, the U.S. Forest Service planned a draft and final EIS on the environmental effects of its proposed program and of alternative programs. A document outlining possible alternative program goals resulted in substantial agency and public comment in the spring of 1975. The draft statement addressed the alternative programs that reflected public and other agency perceptions of realistic program choices. After circulation of the draft statement and evaluation of comments on it, the Forest Service plans to submit its final program recommendations to the Congress in December.

The CEQ examination of EIS and pre-EIS effects revealed the significant influence of the EIS process on project planning and decisionmaking. Many projects are substantially better and many have been rejected or postponed due to problems raised by agency environmental analyses. Sometimes the decisions are made at the field level before an EIS is drafted, and sometimes they are made at the highest agency or department level after the public comments on a final EIS.

EIS CONTENT AND QUALITY

Integration of the environmental analysis into agency planning and decisionmaking requires continued improvement in both content and quality of the EIS. Properly conceived and written, the EIS is an extremely useful management tool. But too many statements have been deadly, voluminous, and obscure and lacked the necessary analysis and synthesis. They have often been inordinately long, with too much space devoted to unnecessary description rather than to analysis of impacts and alternatives. CEQ Guidelines state that "agencies should make every effort to convey the required information succinctly in a form easily understood, both by members of the public and by public decisionmakers, giving attention to the substance of the information conveyed rather than to the particular form or length of detail of the statement."[7] The Guidelines also state that the EIS should normally focus on the impact of a proposed action and on its alternatives. In fact, the analysis of alternatives has been considered the linchpin of the entire environmental impact statement.[8]

In some situations, the draft EIS may appropriately discuss several alternatives without presenting a single proposal so long as the agency truly does not favor any one of them. In several of its Forest Unit plans, the Forest Service developed and analysed a range of alternatives through draft EIS's. It found that these particular drafts prompted especially thoughtful, complete, and useful responses from other agencies and from the public.

The impact statement itself is not intended to be a scientific or technical document but should instead be based on and reflect a process of sound scientific analyses. The level and extent of detail and analysis in the statement should be commensurate with the importance of the environmental issues involved and with the information needs of both decisionmakers and the general public. Some excellent impact statements are 50 pages long;[9] others require several hundred pages.[10] An agency decision on a new technology, like the nuclear breeder reactor, requires greater length, again to meet the informational needs of the public and the decisionmakers. In any event, although the EIS should be able to stand by itself as a document, better use of appendices, informative summaries, references to supporting scientific papers, and more reliance on agency program statements, designed to analyze the effects of generic actions or

An EIS carefully analyzed the significant impacts of proposed phosphate surface mining on Florida's Osceola National Forest. Shown here are Pond Cypresses.

actions having regional impacts, should increase the utility and reduce the bulk of EIS's.

The entire EIS process can be a better, more efficient, and dependable aid to decisionmakers while contributing more to general knowledge, if more attention is paid in the analysis to established scientific practices and, in the EIS's, to scientific references. As the EIS process matures and more scientists participate, there is a growing need to ensure that information developed en route is not lost. Loss now occurs when the information on which EIS's depend is neither published in the scientific literature or otherwise referenced.[11]

EIS REVIEW AND COMMENTING PROCESS

Under section 102(2)(C) of NEPA, the purpose of the review and commenting process is to alert federal agencies with jurisdiction and expertise, as well as state and local agencies and the public, to proposed actions so that they can make constructive recommendations. Most agencies draw upon the views of other federal agencies before circulating a draft EIS. Moreover, several circulate preliminary draft statements to other agencies' field offices and to local and state agencies and citizen groups for early comment. Consequently, evaluation of the formal draft EIS commenting process is not a true reflection of the entire review process.

The formal commenting process is nonetheless critical in preventing and mitigating environmental damage. In many cases, comments by the public and by public agencies have resulted in negotiated changes in projects. Occasionally, however, the commenting process results in trivial or uninformed comments. There is an apparent need for better public understanding of agency programs and of the commenting process. Clearer priorities within the agencies are also needed. In particular, federal agencies with relevant experience should comment on the socioeconomic impacts of proposed projects on existing communities or the new housing, health facilities, school or recreation opportunities, and other services that may be required when a dam or energy facility is built. Another clear need is to improve the energy impact analysis of such nonenergy projects as recreational developments. Focus on just these kinds of effects in the commenting process will improve EIS's considerably.

NEPA–RELATED COSTS AND DELAYS

Agency Cost Estimates

It may not be possible to determine the real costs of federal compliance with NEPA for several reasons. First, some agencies—such as the Forest Service—developed environmental procedures and staff in accordance with laws passed prior to NEPA. For them NEPA simply elaborated upon and modified an older resource management system, so that much of the planning and decisionmaking whose costs are now attributed to NEPA in fact preceded NEPA. Other agencies, such as the Corps of Engineers and the Atomic Energy Commission, analyzed specific environmental issues, radiological or water quality effects of projects, for example, prior to NEPA. These costs too have become part of their NEPA-related cost accounting.

Second, federal agencies are all affected by laws like the Fish and Wildlife Coordination Act of 1934,[12] the Federal Water Pollution Control Act of 1972,[13] and the Clean Air Act of 1970; [14] they require some special environmental analyses that may make cost estimates specific to NEPA difficult.

Third, many agencies, such as ERDA, Commerce, the Forest Service, DOT, and HEW, have no established method of determining NEPA costs because the costs are so much a part of their administrative planning and decisionmaking procedures. Consequently, their estimates can be considered only approximate.

Finally, the agencies that do determine NEPA-related costs, the Corps of Engineers, NRC, SCS, and the Department of Defense, reckon them quite differently. Within the Department of the Interior, each bureau determines costs in accordance with its own needs. The Bureau of Land Management's cost accounting system includes the preparation and review of impact statements as well as the environmental analyses, whereas the Bureau of Outdoor Recreation identifies the costs associated with reviewing but not preparing EIS's because the latter is considered a cost of doing business.

Unless these differences are borne in mind, comparisons among the agencies can be quite misleading.

Estimated NEPA-related costs are shown in Table 1. They are relatively small compared to annual budgets or to the costs of major construction or licensing projects. For example, the Corps of Engineers estimates that in fiscal year 1974 it spent about $21.9 million on NEPA, which is approximately 1.25 percent of its annual operating budget. The NRC estimates that it spent $14.9 million on NEPA in 1975, which is about 2.2 percent of the cost of an average size nuclear powerplant.

Delays

Questions about NEPA's value occasionally arise when it appears that projects are held up by federal environmental impact statement procedures. In the first few years of NEPA, delays did occur due to administrative inefficiencies in completing environmental analyses early in the planning process. Delays also resulted from court orders to hold up projects until NEPA analyses were made. Now, however, federal agencies have virtually eliminated the old issue of "NEPA-caused delays" by beginning environmental studies early and, if necessary, by preparing an adequate draft statement in the course of program and project planning. Even so, litigation based on NEPA continues to be brought by environmental, business, and

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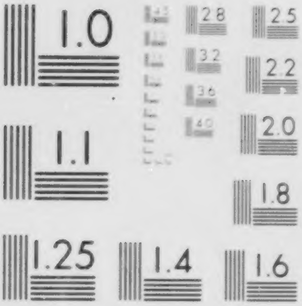
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Table 1

Federal Agency Costs of Environmental Impact Statement Preparation and Review and Comment

Agency	Does the agency have formal procedures for determining NEPA costs?	FY 1974 estimated EIS preparation costs [1]	FY 1974 cost of review and comment process [1]	FY 1974 total EIS cost and review/comment cost [1]	FY 1974 total costs as percentage of operating budget [2]	FY 1975 EIS preparation costs—estimated [1]
COE	yes	$21,933,832 [3]	$76,000	$22,009,832	1.2	$27,057,447 [3]
USDA						
FS	no—use estimates	27,000,000 [4]	225,000	27,225,000	2.7	27,000,000 [4]
SCS	no—use estimates	3,500,000 [5]	360,200	3,860,200	1.0	3,500,000 [5]
APHIS	no—use estimates	125,000 [4]	NA	125,000	NA	85,000 [4]
REA	no—use estimates	117,190 [5]	11,295	128,485	0.73	161,630 [4]
DOC	no—use estimates	342,000 [4]	1,174,000	1,516,000	0.1	526,680 [4]
DOD	no—use estimates	5,200,000 [4]	NA	NA	NA	4,200,000 [5]
DOI [7]	no—use estimates	15,200,000 [5]	5,500,000	20,700,000	0.1	23,400,000 [4]
BLM	yes	3,544,243 [5]	305,000	3,849,243	1.3	NA
BOR	yes	575,000 [5]	995,400	1,570,400	1.4	600,000 [5]
BuRec	no—use estimates	3,796,000 [4]	390,000	4,186,000	0.63	4,050,000 [4]
FWS	no—use estimates	NA [5]	1,849,000	NA	NA	NA
NPS	no—use estimates	1,900,900 [5]	545,000	2,445,900	0.54	2,013,600 [5]

USGS	no—use estimates	2,400,000[10]	800,000	3,200,000	1.65	5,000,000[11]
DOT	no—use estimates	31,746,000[6]	250,000	31,996,000	0.18	36,550,000[6]
EPA	yes	1,280,000[6]	1,600,000	2,880,000	0.048	6,300,000[4]
ERDA[12]	no—use estimates	NA	NA	NA	NA	3,400,000[6, 8]
FEA	no—use estimates	NA	NA	NA	NA	330,000[13]
FPC	yes	1,481,419[6]	70,000	1,551,419	5.4	1,333,000[6]
GSA	no—use estimates	1,600,000[6]	5,000	1,605,000	0.18	2,235,000[6]
HEW	no—use estimates	40,000[5]	100,000	140,000	0.0001	80,000[5]
HUD	no—use estimates	6,000,000[3]	275,000	6,275,000	0.07	NA
NRC[6]	yes	NA	NA	NA	NA	14,900,000[6]

NA = Not available.

[1] From responses to a NEPA questionnaire distributed by CEQ to all federal agencies in November 1974.

[2] Operating budgets determined from federal budget figures for fiscal year 1976.

[3] Costs include in-house and contractor staff, inventories, impact assessments, DEIS, FEIS, supplements, and public meetings.

[4] Costs include in-house and contractor staff only.

[5] Costs include in-house staff only.

[6] Costs include in-house and contractor staff, travel costs, research costs, administrative costs, and public hearings but do not include costs of environmental assessments.

[7] Figures for DOI include all Interior agencies including those noted in this table.

[8] Costs include preparation of all environmental assessments as well as the EIS's.

[9] Costs include in-house staff, program services, leave, and other indirect costs for all environmental assessments and EIS's.

[10] Costs include in-house staff and the cost of obtaining other agencies' expertise.

[11] Costs include in-house and contractor staff and the cost of obtaining expertise from other agencies.

[12] ERDA and NRC were established in 1975 and thus have no figures for fiscal year 1974.

[13] Costs include consultant fees, NEPA training, and the preparation of a NEPA manual.

other interests. As a result, federal programs or other actions may still be delayed pending settlement or a final court decision. But in nearly all situations when projects are held up these days, the reasons are strictly environmental or, more frequently, are the result of local, community, or political opposition to highly controversial proposals.

The question of NEPA-caused delays was most important for the Department of Transportation's highway program at one time. Because NEPA lacked a "grandfather clause," impact statements were required for projects that were underway prior to NEPA and for projects that had been approved but were not yet begun. In 1971, DOT made a massive effort to comply with NEPA by filing 1,293 draft environmental impact statements. By 1972, it began to catch up. The trend continues (see Figure 1 and Table 2) as the pre-NEPA projects go through the NEPA process and as small highway segments are consolidated into fewer impact statements. Today only 9 percent of all highway projects requires an EIS under the Department of Transportation's NEPA criteria.

Number of EIS's

Looking ahead over the next 2 years, the Council expects more environmental impact statements, in part because of relatively new

Figure 1

Draft Environmental Impact Statements
Filed Annually, by Agency

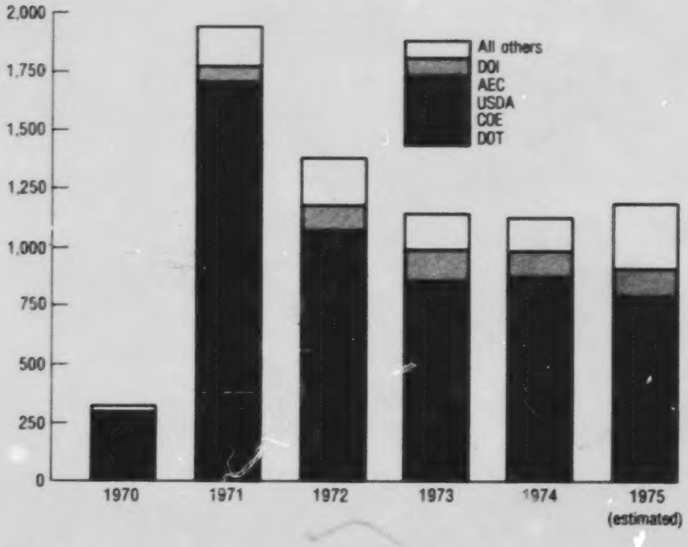


Table 2

Draft Environmental Impact Statements Filed, by Agency, 1970–74 and Estimated 1975

Agency	1970	1971	1972	1973	1974	Estimated 1975	January 1–June 30, 1975
DOT	61	1,293	674	432	360	205	108
COE	119	316	211	243	303	332	147
USDA	62	79	124	166	179	259	110
DOI	18	65	107	119	109	117	38
AEC	32	22	65	28	36	—	—
ERDA	—	—	—	—	—	10	4
NRC	—	—	—	—	—	23	11
HUD	3	23	26	22	21	52	37
DOD	5	27	24	19	21	44	11
GSA	3	34	6	24	26	34	12
EPA	0	16	13	26	14	40	13
All Others	16	75	135	66	68	64	39
Total	319	1,950	1,385	1,145	1,137	1,180	530

agencies like the Federal Energy Administration, the Consumer Products Safety Commission, and the Occupational Safety and Health Administration, as well as because of the increasing application by the older, more established departments. But the main reason is the Corps of Engineers' plans to write some 600 draft EIS's on its operation and maintenance programs for completed projects. The Corps expects to cut its number nearly in half in fiscal year 1977 as O&M is consolidated into program EIS's. For highways, the number of statements should decrease and level off. It should remain fairly constant for airports and energy-related projects. (See Figure 2 and Table 3.)

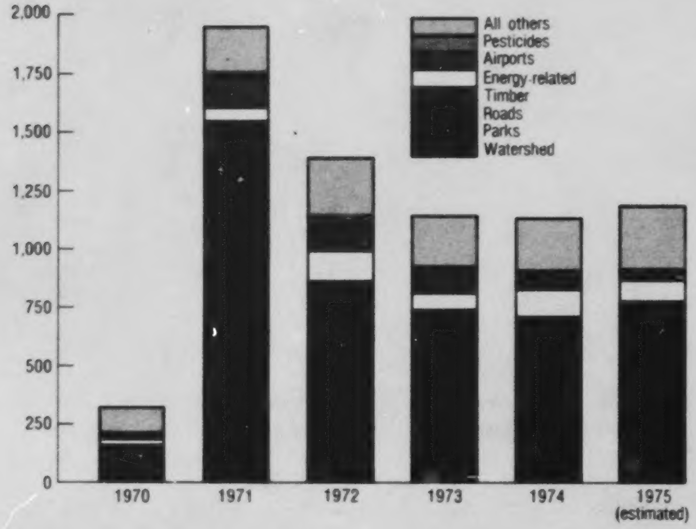
EIS Preparation Time

When to begin and how long it takes to complete impact statements vary considerably, depending on the type of project, the experience of the persons preparing the statement, the relationship of the statements to the decisionmaking process, and the priority accorded the statements by the agency management.

Considerable differences exist among the agencies and their subunits. The Department of the Interior, with its great range of actions and internal administrative procedures, estimates that draft statements on simple projects prepared by experienced personnel require some 3 to 5 months, which time should be reduced in the near future. Complex projects, or simple ones prepared by the inexperienced, may double the time required, and complex projects prepared by inexperienced personnel may take up to 18 months to prepare. If a project or program is not considered on the critical path of Interior's decision process, as may be the case for some water resources and land management plans, then more time may be taken. And as is true

Figure 2

Draft Environmental Impact Statements Filed Annually, by Project



in other agencies, for some projects and programs it may take years to develop a draft EIS.

Once an agency has written a draft, delay in responding to comments and issuing a final statement may reflect the magnitude of the project and the need to respond carefully to a large volume of comments received or the desire of an agency to conduct further study. Most often, however, a final EIS is issued not more than 1 year after the draft is filed.

LEGAL DEVELOPMENTS

In the last year courts have focused more than in the past upon the refinement of specific concepts central to the scope and preparation of environmental impact statements. With 5 years of decisions to interpret, courts have been forced to identify trends and patterns of opinions, some of which are discussed in this section.

PROGRAM ENVIRONMENTAL IMPACT STATEMENTS

An environmental impact statement may appropriately encompass more than a single proposed project. According to CEQ Guide-

Table 3

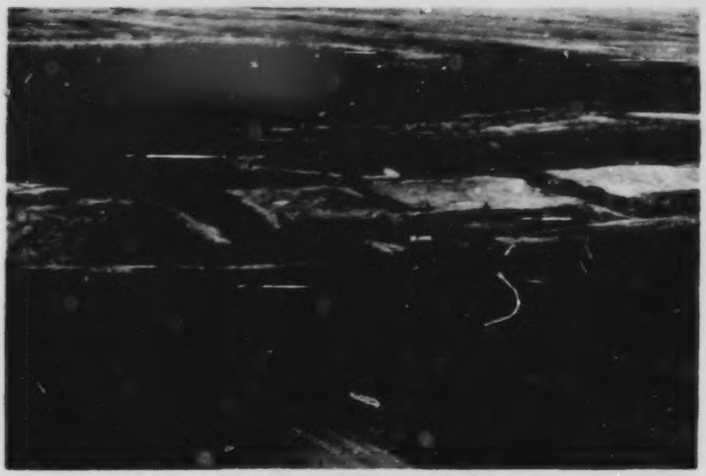
Draft Environmental Impact Statements Filed, by Type, 1970–74 and Estimated 1975

Type	1970	1971	1972	1973	1974	Estimated 1975	January 1–June 30, 1975
Watershed, flood control, navigation	97	392	210	263	273	411	195
Parks, wildlife, refuges, forests	2	24	84	111	134	143	49
Roads	41	1,123	543	305	280	155	93
Timber management	5	1	26	58	24	67	11
Energy	36	59	128	74	114	92	48
Airports	15	141	119	96	66	30	7
Pesticides, herbicides	2	16	26	15	14	7	5
All others	121	194	249	223	227	275	122
Total	319	1,950	1,385	1,145	1,137	1,180	530

lines, program statements may be necessary to assess the effects of individual actions on a given geographical area (e.g., coal leases), to assess environmental impacts that are generic or common to a series of agency actions (e.g., maintenance or waste handling practices), or to assess the overall impact of a large-scale program or chain of contemplated projects (e.g., major lengths of highways, as opposed to small segments).[15] Of the three situations, the circumstances of a project requiring generic action statements have been most clearly defined by agencies and the courts.[16] Other kinds of program statements, however, are a source of continuing thought and discussion among federal agencies and among commentators on NEPA outside government.

Recent decisions of courts of appeals for six circuits provide the beginning of a useful legal framework for determining the scope of a program environmental impact statement. The most comprehensive discussion of program statements is in Judge Skelly Wright's opinion in *Sierra Club* v. *Morton*.[17] Here the U.S. Court of Appeals for the District of Columbia considered whether a program EIS was required for the development of coal in what is known as the Northern Great Plains Province, which covers northeastern Wyoming, eastern Montana, western North Dakota, and western South Dakota as well as small strips of Nebraska and Colorado.

The issue before the court was whether the requirement that comprehensive EIS's be prepared for acknowledged programs (*Scientists' Institute for Public Information* v. *AEC*[18]) should be extended to situations in which the responsible agencies do not believe that their actions constitute a program. The court held that a comprehensive agency program requires an accompanying EIS even if the



Federal courts required further EIS analyses for federal plans to develop coal in the Northern Great Plains region. Shown above is the Knife River Coal Mining Company, near Beulah, North Dakota.

agency has not defined its actions as a program.[19] In this case, said the court, the Department of the Interior had indeed treated its actions regionally in such a way that cumulatively they comprise a major federal action.[20]

The question then was when a program statement is required. The court restated the factors originally set forth in *Scientists' Institute for Public Information* v. *Atomic Energy Commission*, the *SIPI* case:

- How likely is the program to come to fruition, and how soon will that occur?
- To what extent is meaningful information presently available on the effects of implementation of the program and on alternatives and their effects?
- To what extent are irretrievable commitments being made and options precluded as refinement of the proposal progresses?
- How severe will the environmental effects be if the program is implemented?[21]

The test for whether an EIS is required was thus also adopted to determine when in the agency decision process it should be prepared. The court found insufficient evidence on the record to determine whether the time was ripe for preparation of a program EIS. Further, the court found that the Department of the Interior had not yet decided what action it was going to take in development of the region. Consequently, the case was remanded pending decision on federal participation and presentation of enough evidence to judge the needs for a program statement.

The *Northern Great Plains* opinion leaves many questions unanswered. The test devised in *SIPI* was used to determine if an EIS should be prepared on a clearly defined program. It was then applied in *Northern Great Plains* to decide whether the time had arrived, as a program was being developed, to prepare an EIS. Although the test concerns the question of timing, it was also used in the last year as a test for what activities constitute an action to be analyzed in a program EIS. In *Conservation Society of Southern Vermont* v. *Secretary of Transportation,*[22] significant questions related to whether the environmental impact statement should cover part of a road or an entire highway corridor. The Federal Highway Administration clearly did not deliberately segment the project just to avoid the demands of NEPA[23]; it simply adopted the project planning scope of the involved state highway department. The court, however, applied all four elements of the *SIPI* balancing test and concluded that a program statement for the entire corridor was preferable to a separate statement for each segment. It went further by enjoining construction of the segments pending preparation of the program statement. In *Conservation Society,* the court placed heavy emphasis on the irretrievable commitments being made and the options precluded by planned actions and adopted the district court's finding that construction and use of the road segment would create pressure for further construction.[24]

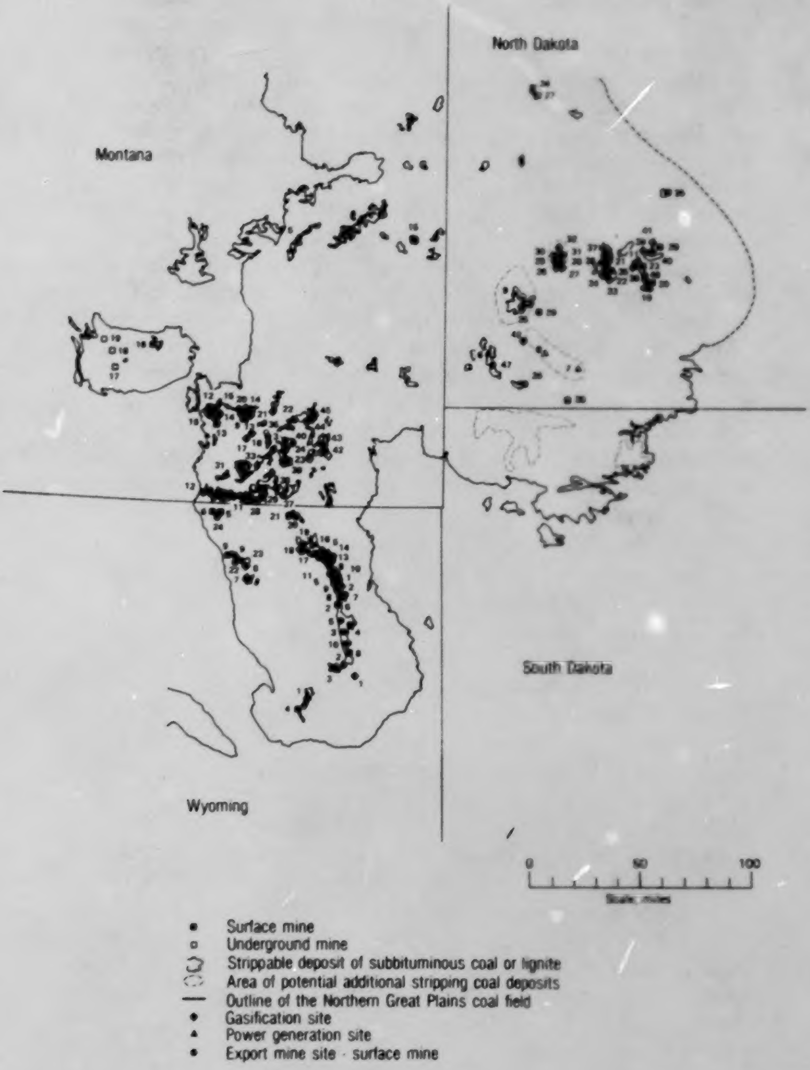
The reasoning of *Conservation Society* was followed and the same conclusion reached by the District Court of New Hampshire in *Appalachian Mountain Club* v. *Brinegar,*[25] a similar highway case. The same conclusion may be inferred from the Sixth Circuit opinion in *Swain* v. *Brinegar.*[26] In *Swain* the court did not speak in terms of program statements. However, it did hold that an EIS considering alternate corridor alignments was required rather than merely addressing environmental considerations within a single chosen corridor.

The Court of Appeals for the Ninth Circuit seems to reach a position contrary to the *Conservation Society/SIPI* rule in *Daly* v. *Volpe.*[27] There the highway segment in question was the last of a long corridor. The alternatives were so limited that explicit and strict application of Judge Wright's four factors might well have produced the same result.

Three decisions in the past year involving reclamation programs used similar language that at first seem at odds with the highway cases. In *Sierra Club* v. *Callaway,*[28] the Court of Appeals for the Fifth Circuit reversed a district court holding that the Wallisville Project in Texas was part of the Trinity River Project and therefore that Wallisville could not be completed until a Trinity River program EIS was prepared. The appellate court interpreted the facts differently than the district court—not the law—holding that the record did not support a finding that Wallisville and Trinity River were part of the same program; Wallisville was part of a Wallisville-Livingston program but Trinity was separate. The court indicated

Figure 3

Extensive Development Forecast for the Northern Great Plains


North Dakota
Montana
South Dakota
Wyoming
0
50
100
Scale, miles
● Surface mine
○ Underground mine
Strippable deposit of subbituminous coal or lignite
Area of potential additional stripping coal deposits
— Outline of the Northern Great Plains coal field
● Gasification site
▲ Power generation site
● Export mine site · surface mine

Source: Northern Great Plains Regional Commission, 1973.

that the required program statement was being prepared for the multiple-unit Trinity River Project.

The language of *Sierra Club* v. *Callaway* is important because it has been quoted and relied upon in factually dissimilar situations:

> We conclude that the Wallisville and Trinity River Projects are not interdependent. The nexus between the projects is not such as to require an EIS evaluation of the Trinity Project as a condition precedent to an EIS evaluation of Wallisville. The Wallisville EIS should speak for itself. Wallisville is a separate viable entity. It should be examined on its own merits. Although it has been made compatible in certain of its features with Trinity, it is not a mere component, increment, or first segment of Trinity.[29]

In Judge Wright's words, the holding of *Sierra Club* v. *Callaway* is that no program exists. Consequently, because the court did not cross that threshold, it did not address the question of scope of a program statement.

The Bureau of Reclamation relied heavily upon the "separate viability" language of *Callaway* in *Sierra Club* v. *Stamm.*[30] Plaintiffs sought to enjoin construction of a single aqueduct and collection system within a reclamation program, arguing against construction until the EIS on the aqueduct and collection system was amended to consider the entire program. The government argued that the smaller system was justified on its own merits and using the separate viability language of *Callaway* as authority, construction of the aqueduct and collection system should proceed.

The court accepted the argument. Because the collection system did have independent utility, construction would not be an irretrievable commitment of resources that would preclude alternatives for the rest of the reclamation program. Under the *SIPI* rule, then, an injunction was not appropriate because one of the four factors was not present.[31] However, although the language of the opinion is ambiguous, the facts of the case indicate the court's intention to go beyond this narrow holding and to decide as well that no program statement need be prepared on the reclamation program. Should the decision have that effect, it clearly conflicts with the *Conservation Society/SIPI* rule—a conflict noted by Judge Wright in *Northern Great Plains.*[32]

The concept of independent utility was also used in *Trout Unlimited* v. *Morton.*[33] That case involved two phases of the Teton Dam and Reservoir Project. Phase One was the subject of the EIS and Phase Two was in early planning. Plaintiffs sought to enjoin construction until a statement was prepared considering both phases, but the court refused to require the single program EIS. Again, however, although a program statement may have been a more appropriate way to proceed, it is not clear that an injunction on the project was required under the strict rule of *SIPI* because there were no significant irretrievable commitments of resources made.

Even when a program environmental impact statement is required, "[s]ubsequent statements on major individual actions will be necessary where such actions have significant environmental impacts not adequately evaluated in the program statement."[34] For the last several years, courts have in theory accepted a hierarchy of EIS's.[35] This concept was first supported in *Natural Resources Defense Council* v. *Morton*,[36] where plaintiffs sought successfully to compel the Bureau of Land Management to prepare "geographically individualized" impact statements on the grazing program under the Taylor Grazing Act even though BLM was preparing an EIS on the entire grazing program. The court held that substantial issues related to specific areas should be dealt with in subsequent environmental impact statements.

The Court of Appeals for the Ninth Circuit adopted the reasoning of the grazing permit case in *Cady* v. *Morton*.[37] In *Cady*, almost a companion case to the *Northern Great Plains* decision, the court approved the D.C. court's requirement of a program statement. In addition, the court required an EIS on development of a 31,000-acre lease and on individual mining plans for portions of the lease.[38]

DELEGATION OF EIS PREPARATION

The propriety of agencies' delegating preparation of impact statements remained of paramount concern to courts, federal agencies, and the Congress until the Congress resolved the issue in the summer of 1975. The basic rule remains unchanged since it was enunciated by the Court of Appeals for the Second Circuit in *Greene County Planning Board* v. *Federal Power Commission*.[39] There the court held that NEPA explicitly requires the agency's own detailed environmental impact statement and that the FPC was in violation of NEPA by conducting hearings on a powerline application using an EIS prepared by the applicant prior to preparation of FPC's own impact statement.[40] On the other hand, the court supported AEC procedures requiring the AEC staff to prepare a draft but permitting the draft to be based upon a very detailed environmental report submitted by the applicant.

There are two elements of this strict rule on delegation. Section 102(2)(C) of NEPA states that "[p]rior to making any detailed statement the responsible Federal official shall consult with" all agencies with expertise on or jurisdiction over the subject of the statement. The implication is that the EIS must actually be assembled by the responsible federal official. In addition to relying upon language of NEPA, the courts have relied upon its general policy to improve the objectivity of agency decisionmaking. In *Greene County* the court indicated in strong terms that this objective could be destroyed by self-serving statements and that it was unlikely that an applicant's statement would be free from such defects.[41]

Whether this general rule applies to grants to the states under the Federal-Aid Highway Act has been the subject of considerable debate.[42] There is an arguable distinction. State highway agencies have historically had the primary responsibility for planning and design. Corridor selection and many other major decisions are made pursuant to federally approved procedures but before a request for federal funding. Further, because these decisions are made by the state, it may be appropriate to involve state decisionmakers in EIS preparation. On the other hand, FHWA has ultimate project approval authority, and the policy obligations of NEPA—including implementation of section 101—remain at the federal level. In addition, the underlying policy consideration of avoiding self-serving statements in an EIS may be as applicable to state highway agencies as to other nonfederal entities. The environmental policies of NEPA are national, and there is a strong argument for decisions that affect all citizens to be made by an agency responsible to all citizens rather than to residents of a single state. Cases reflecting these policies were discussed in CEQ's Fifth Annual Report.[43]

Against this background of cases, the Court of Appeals for the Second Circuit decided *Conservation Society of Southern Vermont* v. *Secretary of Transportation* in December 1974. That opinion was followed shortly by opinions adopting the *Conservation Society* analysis for the Seventh Circuit [44] and the District of New Hampshire.[45] In *Conservation Society* the court held that FHWA must literally prepare the EIS—NEPA was not satisfied by state preparation of an EIS under FHWA supervision.[46]

The contradictory interpretations of *Conservation Society* resulted in confusion nationally about the role of state highway departments in FHWA NEPA compliance. To resolve this confusion, the Congress adopted the first amendment to NEPA. It was intended to clarify, not change, existing law. The amendment inserts the following new subparagraph "D" into section 102(2):

> (D) Any detailed statement required under subparagraph (C) after January 1, 1970, for any major Federal action funded under a program of grants to States shall not be deemed to be legally insufficient solely by reason of having been prepared by a State agency or official, if:
>
> (i) the State agency or official has statewide jurisdiction and has the responsibility for such action,
>
> (ii) the responsible Federal official furnishes guidance and participates in such preparation,
>
> (iii) the responsible Federal official independently evaluates such statement prior to its approval and adoption, and
>
> (iv) after January 1, 1976, the responsible Federal official provides early notification to, and solicits the views of, any other State or any Federal land management entity of any action or any alternative thereto which may have significant impacts upon such State or affected Federal land management entity and, if there is any disagreement on such impacts, prepares a written assessment of such impacts and views for incorporation into such detailed statement.
>
> The procedures in this subparagraph shall not relieve the Federal official of his responsibilities for the scope, objectivity, and content of the entire statement or of any other responsibility under this Act; and further, this subparagraph does not affect the legal sufficiency of statements prepared by State agencies with less than statewide jurisdiction.

To fall within the scope of the amendment, an impact statement project must be part of a federal grants program and the recipient must be a statewide agency with statewide jurisdiction. The Conference, House, and Senate committee reports[47] indicate that the amendment is restricted to this narrow fact situation. The reasons given are several. First, if the action is a grants program, the recipient is responsible for the bulk of the planning, design, and project preparation. A state agency serving only as a conduit for funds to local governments would not be affected by the amendment. The grantee, having the most information about a project, is the agency that will need to incorporate environmental tradeoffs into the project design and thus should participate in preparation of the EIS. Second, a statewide agency is more likely to have the staff resources to ensure the interdisciplinary examination of environmental issues mandated by NEPA and by CEQ Guidelines. Smaller units of government seldom do. The problem of providing interdisciplinary expertise at the local government level is discussed further in a later section of this chapter. A third reason mentioned in the Congressional reports on the NEPA amendment is that a statewide agency has political responsibility to the whole state. The fear of self-interested statements, expressed in *Greene County* and many of the decisions adopting the *Greene County* rule, is lessened somewhat when there is an assurance that the agency preparing an EIS has a broad-based rather than a narrow and single-purpose constituency.

The amendment requires the responsible federal official to furnish guidance and to participate in preparation of the statement. A federal official is thus prevented from receiving a completed statement without prior involvement and then adopting or rejecting it; the official must be involved in the preparation. Committee reports indicate that this language was intended to restate the requirements of section 7(c) of the CEQ Guidelines.[48]

The responsible federal official must independently evaluate the statement prior to approving and adopting it. Delegation of the ministerial act of writing or compiling an EIS is not to be misconstrued as delegating other agency responsibilities under section 102 (2)(C), the Senate report emphasizes: "[T]he bill does not sanction a 'rubber stamp' approach to Federal responsibilities, nor does it allow Federal functionaries to sidestep the other responsibilities placed upon them by law including, but not limited to, NEPA."[49]

When another state or federal land management entity has an interest independent of the state preparing an EIS, the responsible federal official has an additional duty to provide early notification of the proposal to those states or federal entities. The official must solicit the views of the other state or federal entities and prepare a written assessment of the impacts and views for incorporation into the statement if there is disagreement on the action, on alternatives to the action, or on the impacts of the action or its alternatives. Thus state agencies are relieved from the need to describe and analyze alternatives and impacts outside their jurisdiction and expertise.

The last sentence of the amendment contains two caveats. The amendment in no way relieves the federal official of his responsibilities for the adequacy of the statement or any other NEPA responsibilities. In addition, the conference committee added a provision stating that nothing should be inferred from the amendment concerning the legal sufficiency of statements prepared by state agencies with less than statewide jurisdiction.

This new provision was added because it was feared that the amendment would be interpreted to forbid any kind of delegation by federal agencies to state agencies of less than statewide jurisdiction. Because that question was entirely outside the scope of the Congressional inquiry, the Congress was careful to ensure that the law regarding agencies of less than statewide jurisdiction was not unintentionally altered in any way.

REVENUE SHARING

General revenue sharing may be the most limited possible federal involvement in state and local affairs. The only federal act consists of the distribution of a portion of federal tax collections to the states and more than 38,000 units of local government. Because the federal officials involved have no control over use of the funds, they make no decisions for which an environmental impact statement would be meaningful. Under CEQ Guidelines an environmental impact statement is not required for the expenditure of general revenue sharing funds.[50] The courts have affirmed that position.[51]

Another version of revenue sharing involves federal funding for specific categories of projects, but with individual project approval authority delegated to the recipient state or local government. An example is the community block grant program in the Housing and Community Development Act of 1974.[52] Unlike general revenue sharing, however, it was clear to the Congress that these grants might be used for major actions significantly affecting the human environment. The question remained: Are the actions federal? If so, how can NEPA be implemented in a meaningful way when all decisions are made at the local level?

The Congress then created a system to apply NEPA to this new form of grants. Under section 104(h) of the Housing and Community Development Act the recipient local government takes on the role of a division of HUD and must carry out "all of the responsibilities for environment review, decisionmaking, and action" under NEPA that would apply to the Secretary of Housing and Urban Development if the projects were federal.[53] As part of a grant application, the responsible local official must certify that the applicant has fulfilled all NEPA obligations (not just preparation of an environmental impact statement), that the certifying official agrees to assume the role of responsible official under NEPA, and that both the official and the applicant waive all immunity to suit in federal court to enforce the obligations of NEPA. Because many local governments lack the resources to provide the trained, interdisciplinary team to do the analysis and research required by NEPA, the local government may use up to 10 percent of the grant for project planning and compliance with NEPA requirements.

The regulations for this innovative program were developed by HUD and CEQ, and the first impact statements have already been filed.[84] Like statements prepared by any federal agency, the local government statements under the community block grant program are filed with CEQ and reviewed by federal agencies. They too are open to public examination and comment.

NEPA AND REGULATORY PROCEEDINGS

On June 24, 1975, the Supreme Court handed down its first major NEPA decision in *Aberdeen and Rockfish Railroad* v. *Students Challenging Regulatory Agency Procedures.*[85] The Court faced a unique set of facts. The nation's railroads had filed a proposal with the ICC to raise freight rates, including rates on recyclable scrap materials. Concurrently the ICC was investigating the entire rate structure—including its environmental effects—in a separate proceeding. As part of its consideration of the rate increase, the ICC prepared a very cursory draft impact statement, followed 7 months later by an abbreviated "environmental report" released with the commission's decision approving the increases. The plaintiffs sought to enjoin the decision, which prompted the ICC to write new draft and final impact statements and to reconsider its decision. When the commission later reaffirmed its initial decision, the plaintiffs challenged the adequacy of the commission's environmental assessment and statements.

In reviewing the ICC's environmental statements, the Supreme Court observed that two draft statements had already been prepared and suggested that the environmental implications of the rate increases were minimal and temporary. It found the other proceeding—the investigation of the rate structure—to be the more "appropriate" one for considering the broad environmental issues, such as effects of freight rates on recycling incentives, raised by the plaintiffs. It concluded that the shorter statements for the rate increase proceeding were adequate in light of the potential environmental effects involved, the narrow scope of the proceeding, and the broader concurrent investigation of environmental aspects of the freight rate structure.

Procedurally, the Court held that the ICC's final impact statement was not due until the commission issued a "report or recommendation" on a "proposal for federal action." Since the ICC's "report" was its initial decision on the railroad's proposed rate increase, the Court excused the commission's failure to prepare a final statement in time for hearings which preceded the "report," noting that a draft statement was available. The holding has raised the question whether some federal licensing agencies may defer preparation of final statements until a hearing board issues a report or recommendation.

Substantively, *SCRAP II* supports the principle that the depth and detail of a statement may be tailored to the intensity of the potential environmental consequences of a federal action. This general proposition is consistent with the CEQ policy of urging agencies to prepare shorter and more analytical statements unless the scope of a project or its potential environmental effects require a more comprehensive document. This holding should also help dispel the widely held misconception that legal adequacy is a function of a statement's length.

CONCLUSION

Legal developments this year focused more on a few issues than on the broad range of questions of early years. The impact statement was designed as an action-forcing mechanism, and interpretations of NEPA reinforced this purpose. Program statement cases focused on the scope of environmental impact statements, with courts and agencies struggling to identify the kind of statement that would best inform decisionmakers and lead to decisions fulfilling NEPA's purposes. The Congress reiterated the importance of ensuring that the responsible official is fully informed about environmental consequences of agency actions. Both the NEPA amendment and the NEPA provisions of the community block grant program are statutory expressions that environmental considerations and decisionmaking are inextricably linked.

STATE ENVIRONMENTAL IMPACT STATEMENT REQUIREMENTS

Since our compilation of state environmental impact statement requirements a year ago,[56] one additional state, New York, passed an environmental conservation act and several states amended their environmental laws or executive orders.

In June 1975, the New York Legislature passed a broad environmental conservation act which requires an environmental impact statement for every state and local agency action which may have a significant effect on the environment.[57] "Action" as defined in the statute includes (1) projects or activities directly undertaken or supported by any agency or those involving the issuance of a lease, permit, license, or certificate and (2) policy, regulations, and procedure-making.[58] The New York act grants to the Commissioner of the

Department of Environmental Conservation the authority to adopt rules and regulations to implement the provisions of the act, including the power to establish criteria for impact assessment and to publicize agency findings.[59] The act also provides that an agency may hold hearings on the impact of a particular action after it issues an impact statement.[60]

Most other state EIS requirements have been in effect for at least 2 years. During the past year, a number of states amended their environmental laws. In general, the changes increase the strength and durability of the environmental impact procedures.

California, Hawaii, Maryland, Michigan, Texas, Virginia, and Washington all amended their statutes or executive orders within the past year. California now requires that impact statements include a discussion of mitigating measures relating particularly to the wasteful and unproductive consumption of energy.[61] Amendments to Virginia's statute provide for an Administrator of the Virginia Council on the Environment who is responsible for "developing uniform management and administrative systems which will assure coherent environmental policies and will facilitate the provision of environmental services to the public." [62] Washington amended its state Environmental Policy Act to provide for a "watchdog" agency—the Council on Environmental Policy—to oversee the act's implementation.[63] By revising two previous executive orders, Michigan established an Environmental Review Board, which is responsible for advising the Governor, suggesting environmental policy, conducting public hearings, and assisting the Governor in the review of state environmental impact statements.[64] Hawaii, Maryland, and Texas made minor and/or wording changes in their statutes, leaving the basic policy goals intact.[65]

A few states, notably Connecticut, North Carolina, and South Dakota, have had problems in implementing their environmental statutes. The most significant setback to the progress of state environmental impact assessment took place in Connecticut. During 1975, the Connecticut Department of Environmental Protection developed guidelines intended to:

- Assist each state agency to fulfill its responsibility to evaluate proposed actions which may significantly affect the environment, alternatives to such actions, and the environmental consequences of such actions.
- Assist governmental agencies, the public, and other interested persons in reviewing and commenting on documents prepared under these regulations.[66]

However, the state Attorney General found nothing in the Connecticut Environmental Protection Act which would grant the Department of Environmental Protection the authority to propose such regulations. The Environmental Protection Act was returned to the state legislature for clarification. The legislature chose to do so by removing all authority enabling the Department of Environmental

Protection to propose guidelines for the effective implementation of the Connecticut Environmental Protection Act.[67]

The South Dakota Environmental Policy Act, as proposed, required that each state agency compile and use its own implementation guidelines, but the state legislature passed the act without providing for such authority. To date, the South Dakota Department of Environmental Protection is the only state agency to issue guidelines, which are considered merely advisory.[68]

The North Carolina Department of Natural and Economic Resources attributes poor implementation of its Environmental Policy Act to a similar lack of enforcement authority. The act is due for renewal in 1977.[69]

Thus the status of state NEPA laws appears to be mixed. Efforts in some states to achieve compliance with the law are presently hampered by inadequate enforcement authority. Where adequate statutory authority does exist, lack of expertise in handling environmental affairs and inadequate funding frequently pose critical problems to effective implementation. In addition, some states are finding it necessary to make adjustments in both statutory requirements and administrative procedures to reflect the particular organizational, environmental, political, and other needs of their respective jurisdictions. In all cases, the next few years will witness important tests of the new state policies and procedures for environmental assessment.

The appendix to this chapter lists the 24 states which, as of April 15, 1975, have adopted an impact statement process. For each the appendix contains citations to the legal authority for the process; any guidelines which have been issued as of August 1; and the name, address, and phone number of individuals who may be contacted for further information.

INTERNATIONAL DEVELOPMENTS

The development and strengthening of environmental impact assessment procedures in the United States have parallels in the international community. In November 1974, the Organization for Economic Cooperation and Development (OECD) adopted the recommendations that member governments "(1) establish procedures and methodologies for forecasting and describing the environmental consequences of significant public and private projects likely to have a major impact on the quality of the environment; (2) exchange information on environmental matters which would help them to forecast and describe the environmental effects of proposed programmes or projects." [70] Subsidiary bodies of the OECD Environment Committee are currently working on a project to implement these recommendations.

During the past year, individual governments in western Europe continued to investigate or implement the environmental impact assessment mechanism. In February of 1975, the French Conseil de Ministres submitted to Parliament a bill which would require that all projects undertaken, authorized, or approved by a public agency be preceded by the preparation of an "étude d'impact écologique," an ecological impact study. Regional environmental commissions and a National Commission on the Environment would be established to review the proposed actions.[71] In the United Kingdom, the government has appointed a study team to inquire into the use of environmental impact analysis for development proposals. The study team is apparently inclined to favor the integration of environmental impact analysis with the British Planning System. In May 1974, West Germany and the United States entered an agreement on cooperation in environmental affairs. The agreement states that the nations "through their appropriate agencies—will maintain and enhance bilateral cooperation in the field of environmental affairs on the basis of equality, reciprocity and mutual benefit" and specifies environmental impact evaluation as an area requiring cooperation.[72]

Canada has established environmental assessment procedures through administrative measures rather than through law. The Canadian procedures will encompass projects sponsored by the federal government, projects executed on federal lands, and projects partially or wholly financed by the federal government. Proponents of significant projects in these categories of action must prepare comprehensive evaluations of the environmental impacts of the projects for government review and modification.[73] In Japan, interest in the EIS concept also accelerated. Japan's Environment Agency issued an interim report on environmental impact statement procedures, and the Ministry of Trade and Industry proposed assessment procedures for major industrial sites.[74] The major political parties and the bar association have also indicated interest in new legislation, and an industrial group formed an environmental impact study team which visited the United States in June 1975.

All these developments indicate that other countries are steadily progressing toward fitting the environmental assessment mechanism to their own needs and procedures.

NEPA IN THE FUTURE

NEPA has required all federal agencies to introduce sound environmental skills and analysis into their planning and decisionmaking, to broaden their consideration of alternatives, to plan with other agencies, and to inform and involve the public at every step of the way. Most of these requirements were long perceived as desirable government objectives, but they were not effected until NEPA became law.

In most federal agencies effective implementation of NEPA depends on the extent to which managers at all levels—particularly the

Effects on the village of Drumbuie, Scotland, of a proposed facility to construct offshore oil platforms for North Sea oil production were the subject of an impact study.

top—accept environmental analysis as a management tool to achieve the act's substantive goals. An increasingly important test of their resolve to use NEPA effectively involves application of EIS procedures to broad policies and programs. The commitment of agencies to integrate the EIS process into program planning is encouraging. The Congress stimulated this process when it passed the Forest and Rangeland Renewable Resources Planning Act of 1974.[75] It required the Forest Service to develop a long-range national program consistent with NEPA's provisions, and the Forest Service responded by making the EIS process a part of this program development.

The important case law on program impact statements has begun to outline the criteria for agencies' deciding whether a program exists and when an EIS is required. Over the next several years these criteria must be supplemented and sharpened to help the agencies use the program statement more effectively. In addition, the relationship of program statements to subsequent project level statements will need clarification based in large part on agency experience with the needs of planning and decisionmaking.

Several other changes can help improve agency implementation of NEPA. One is for agencies to identify more clearly and as early as possible in their planning process the major concerns of decisionmakers and various public interests. These concerns can be identified and analyzed only after early and continuous communication among federal agencies and with the public. Effective communication that makes the EIS process responsive to the issues raised by a proposed action will improve and may speed agency decisions.

Improvements are also essential in the analysis of what are often called secondary impacts. Under NEPA the EIS process must focus on the "human environment," and some of our major concerns about energy development, transportation plans, and other large capital projects involve social and economic effects on housing, public services, jobs, schools, etc. To address these effects adequately requires more and better application of the social sciences, as many federal agencies are recognizing.

One useful way to improve the focus of EIS's, their use in decisionmaking, and their analytical support is to look at past forecasting attempts. Unfortunately, few agencies look back at projects to evaluate their effects, or people's perceptions of their effects, in order to improve future forecasting and decisionmaking. An excellent example of this kind of review is the Bureau of Land Management assessment of the annual 150-mile mass motorcycle race on public land from Barstow to Las Vegas. Interior wrote a first-rate EIS before the race and afterward produced an evaluation report comparing forecasts with actual effects.[76] BLM's evaluation is discussed in the Outdoor Recreation section of Chapter 2.

We believe that these and other improvements can be made within the basic framework established by NEPA. They are necessary refinements of a system of environmental procedures and analyses that serves the federal government well. Understandably, it has become a model for states, localities, and other countries. Fortunately, much thoughtful work is being devoted to the success of this system by people in government, in the universities, in business, and in environmental groups. As a result, the hopeful changes of the past 5½ years promise to continue.

REFERENCES

1. 42 U.S.C. 4321 et seq. (1970). The full text appears in Appendix B.
2. 3 C.F.R. 271 (1970). The full text appears in Appendix D.
3. "Preparation of Environmental Impact Statements: Guidelines," 38 Fed. Reg. 20550–20562 (Aug. 1, 1973). The full text appears in Appendix E.
4. Most of these and several other factors were cited by Allan F. Wichelman, "Federal Agency Implementation of the National Environmental Policy Act of 1969: Toward a Framework for Explaining Differential Response," address at the 1975 annual meeting of the Western Political Science Association, Seattle, March 20–22, 1975, p. 26.
5. HUD response to question 2.02 of CEQ questionnaire on implementation of NEPA, Jan. 14, 1975.
6. Forest and Rangeland Renewable Resources Planning Act of 1974, P.L. 93–378, 16 U.S.C. § 1601 et seq. (1974).
7. *"Guidelines,"* supra note 3, § 1500.8(b).
8. *Monroe County Conservation Council, Inc.*, v. *Volpe*, 472 F.2d 693, 697–98 (2d Cir. 1972).
9. For example, National Oceanic and Atmospheric Administration, Environmental Impact Statement, "Proposed Estuarine Sanctuary Grant Award for South Slough, Coos Bay, Oregon" (final, June 21, 1974).

10. For example, U.S. Department of the Interior, Bureau of Land Management, Environmental Impact Statement, "Phosphate Leasing on the Osceola National Forest, Florida" (final, June 27, 1974).
11. Jon Chiselin, "Making the Environmental Report a Contribution to Knowledge," *Ecology,* 56 (1975), 273.
12. 16 U.S.C. §§ 661–66c (1934).
13. Federal Water Pollution Control Act Amendments of 1972, 12 U.S.C. § 24; 15 U.S.C. §§ 633, 636; 31 U.S.C. § 711; 33 U.S.C. § 1251 et seq. (1972).
14. Clean Air Act Amendments of 1970, 42 U.S.C. § 1857 et seq.
15. "*Guidelines,*" supra note 3, § 1500.6(d)(1).
16. See, for example: Atomic Energy Commission, Environmental Impact Statement, "Underground Nuclear Test Program (NTIS)" (final, May 10, 1973); U.S. Army Corps of Engineers, Environmental Impact Statement, "Maintenance of New York Harbor, New York Navigation Project" (final, Aug. 28, 1972); *Lee* v. *Resor,* 348 F. Supp. 389 (M.D. Fla. 1972); *Sierra Club* v. *Mason,* 351 F. Supp. 419 (D. Conn. 1972), 365 F. Supp. 47, 5 ERC 1216 (D. Conn. 1973).

—— F.2d ——, 7 ERC 1977 (D.C. Cir. 1975).

18. 481 F.2d 1079 (D.C. Cir. 1973).
19. —— F.2d ——, 7 ERC 1986–87.
20. Id. at 1988.
21. 7 ERC at 1992.
22. 508 F.2d 927, 7 ERC 1236 (2d Cir. 1974).
23. 508 F.2d 934 ff., 7 ERC 1241–45 ff.
24. Ibid.
25. 381 F. Supp. 282 (D. N.H. 1974), —— F. Supp. —— (D. N.H. 1975).
26. 378 F. Supp. 753, 6 ERC 2067 (S.D. Ill. 1974).
27. 514 F.2d 1106, 7 ERC 1778 (9th Cir. 1975).
28. 499 F.2d 982 (5th Cir. 1974).
29. Id. at 990.
30. 507 F.2d 788, 7 ERC 1245 (10th Cir. 1974).
31. 507 F.2d 790 ff., 7 ERC 1247 ff.
32. 7 ERC at 1991 n. 29.
33. 509 F.2d 1276, 7 ERC 1321 (9th Cir. 1974).
34. "Guidelines," supra note 3, § 1500.6(d)(1).
35. F. Anderson, *NEPA in the Courts—A Legal Analysis of the National Environmental Policy Act* (Baltimore: Johns Hopkins Press, 1973), pp. 177, 220, 290.
36. 388 F. Supp. 829, 7 ERC 1298 (D.D.C. 1974).
37. Civ. No. 74–1948 (9th Cir., July 19, 1975).
38. Id. at 13.
39. 455 F.2d 412 (2d Cir. 1972).
40. Id. at 422.
41. Id. at 420.
42. Federal-Aid Highway Act of 1973, P.L. 93–87, 23 U.S.C. §§ 101 et seq.
43. Council on Environmental Quality, *Environmental Quality—1974* (Washington, D.C.: Government Printing Office, 1974), pp. 393 ff.
44. *Swain* v. *Brinegar,* —— F.2d ——, 7 ERC 2046 (7th Cir. 1975).
45. *Appalachian Mountain Club v. Brinegar,* —— F. Supp. —— (D.N.H., April 1975).
46. 508 F.2d 927, 933, 7 ERC 1236, 1240.
47. U.S. Congress, House, *Amending the National Environmental Policy Act to Clarify the Federal and State Roles in the Preparation of Environmental Analyses of Certain Federal Programs,* H.R. Rep. No. 388, 94th Cong., 1st sess., 1975; U.S. Congress, House, Committee on Merchant Marine and Fisheries, *State Participation in Environmental Analyses,* H.R. Rep. 144, 94th Cong., 1st sess., 1975; U.S. Congress, Senate, Committee on Interior and Insular Affairs, *A Bill To Authorize the Secretary of the*

Interior to Sell Certain Rights in the State of Wyoming, S. Rep. 152, 94th Cong., 2d sess., 1975.

48. "Guidelines," supra note 3, § 1500.7(c).
49. H.R. Rep. No. 144, supra note 47, p. 6; S. Rep. No. 152, supra note 47, p. 10.
50. "Guidelines," supra note 3, § 1500.5(a)(2).
51. *Ely v. Velde* (II), 497 F.2d 252 (4th Cir. 1974); *Carolina Action* v. *Simon*, 389 F. Supp. 1244 (D.D.C. 1975), *aff'd*, —— F.2d —— (4th Cir. 1975) (per curiam).
52. P.L. 93–383, 42 U.S.C. §§ 5301 et seq., 5304(h).
53. Ibid.
54. U.S. Department of Housing and Urban Development, Environmental Impact Statements, "Community Development and Housing Proposal, Block" (draft, Jan. 30, 1975; "Culver City Community Development Plan" (draft, March 4, 1975); "Santa Monica Community Development" (final, April 28, 1975); "San Jose Community Development" (final, June 9, 1975); "San Mateo Community Development" (final, June 16, 1975); "Vegas Heights Community Development, Las Vegas" (final, July 23, 1975).
55. 422 U.S. —, 43 U.S.L.W. 4844 (1975).
56. CEQ, supra note 43, at 421 ff.
57. S. 3540 and A. 4533, passed June 24, 1975, amending New York's Environmental Conservation Law.
58. Id. § 8–0105.2.
59. Id. § 8–0113.
60. Id. § 8–0109.5.
61. Cal. Pub. Res. §§ 21100–25903 (West 1974).
62. Va. Code Ann. §§ 2.1–51.9, 10.181, 10.183, 10.185 (effective April 4, 1974).
63. Wash. Laws, 1974, 1st Ex. Sess., Chapter 179; Wash. Rev. Code §§ 43.-21B, 43.21C (Supp., 1974).
64. Interim Guidelines for the Preparation of Environmental Impact Statements, Executive Order 1974–4 of the Michigan Environmental Review Board, rescinding the provisions of Executive Directive 1971–10 (Sept. 30, 1971) and Executive Order 1973–9.
65. Md. Ann. Code, Natural Resources, § 1–301(c) (effective July 1, 1975); 3 Hawaii Rev. Stat. § 246 (1974); a proposed revision of "Policy for the Environment" was adopted by the Texas Interagency Council on Natural Resources and Environment on March 7, 1972 (available from the Texas Division of Planning Coordination).
66. Connecticut Department of Environmental Protection, "Draft Regulations for the Implementation of the Connecticut Environmental Policy Act," prepared pursuant to Conn. Pub. Act 73–562, February 14, 1975, p. 2.
67. Information supplied by the Connecticut Department of Environmental Protection.
68. South Dakota Environmental Policy Act, House Bill 753, 1974 Legislature, approved March 2, 1974; South Dakota Department of Environment Protection, "Guidelines for Implementing the South Dakota Environmental Policy Act," issued May 8, 1974.
69. Information supplied by the North Carolina Department of Natural and Economic Resources.
70. The Council of the Organization for Economic Cooperation and Development, "Recommendation of the Council on the Analysis of the Environmental Consequences of Significant Public and Private Projects," Paris, November 21, 1974 (adopted by the Council on November 14, 1974).

71. Marc Ambroise-Rendu, "Un Code de la Qualite de la Vie pour 1977," *Le Monde*, Feb. 28, 1975.
72. "Agreement Between the Government of the United States of America and the Government of the Federal Republic of Germany for Cooperation in Environmental Affairs," Department of State Press Release No. 182, May 9, 1974, p. 384.
73. E. Lubensky, memorandum of a meeting held at the Council on Environmental Quality, Washington, D.C., March 27, 1975.
74. Environment Agency Tokyo, "Guidelines for Conducting Environmental Impact Assessments (Interim Report)," *Japan Environment Summary*, Vol. 2, No. 9 (1974), pp. 1, 2; Environment Agency Tokyo, "Fiscal 1975 State Budget for Environmental Protection," *Japan Environment Summary*, Vol. 3, No. 5 (1975), p. 1.
75. P.L. 93–378, 88 Stat. 476.
76. U.S. Department of the Interior, Bureau of Land Management, Environmental Impact Statement, "Proposed Barstow-Las Vegas Motorcycle Race" (final, October 1975), and "Evaluation Report," Sacramento, March 1975.

APPENDIX STATE ENVIRONMENTAL IMPACT STATEMENT REQUIREMENTS, APRIL 15, 1975

STATES WITH COMPREHENSIVE STATUTORY REQUIREMENTS

CALIFORNIA

Source California Environmental Quality Act of 1970, Cal. Pub. Res. Code, Section 21000–21174 (Supp. 1972), as amended by Ch. 56, Statutes of 1974, March 4, 1974, as amended by Ch. 276, Statutes of 1974, Section 21100(c), January 7, 1975.

Guidelines 14 Cal. Admin. Code Ch. 3, Guidelines for Implementation of the California Environmental Quality Act of 1970 (Register 73, No. 50—12—15—73), as amended by order of the Secretary for Resources, March 22, 1974, as amended January 7, 1975, as amended April 1975. Guidelines are prepared by the Resources Agency of California.

State Contact Norman E. Hill, Special Assistant to the Secretary for Resources, The Resources Agency, 1414 Ninth Street, Sacramento, California 95815 (Phone: 916–445–9134).

CONNECTICUT

Source Connecticut Environmental Policy Act of 1973, Pub. Act 73–562 (approved June 22, 1973). Conn. Gen. Stat. Ann. Ch. 439, Section 22a–1, et seq. (Cum. Supp. 1974–1975) (effective February 1, 1975).

Guidelines New guidelines are being prepared by the Department of Environmental Protection. Currently in effect: "Draft Guidelines for the Implementation of Executive Order No. 16," transmitted to the state agencies under Memorandum from the Governor, dated December 13, 1972.

State Contact Mary Ann Massey, Assistant Director of Planning and Research, Department of Environmental Protection, State Office Building, Hartford, Connecticut 06115 (Phone: 203–566–4256).

HAWAII

Source Act 246, Sess. Laws of Hawaii (approved June 4, 1974), Hawaii Rev. Stat. Ch. 334 (1974). This Act supersedes the previous Governor's Executive Order of August 23, 1971.

Guidelines Guidelines are being prepared by the Hawaii Environmental Quality Commission.

State Contact Richard E. Marland, Director, Office of Environmental Quality Control, Office of the Governor, 550 Halekauwila Street, Room 301, Honolulu, Hawaii 96813 (Phone: 808–548–6915).

INDIANA

Source IC 1971, 13–1–10, added by Pub. L. 98, 1972, Ind. Stat. Ann. Section 35–5301, et seq. (Supp. 1971).

Guidelines Guidelines are being prepared by the Environmental Management Board and are scheduled to be completed by fall 1975.

State Contact Ralph Pickard, Technical Secretary, Environmental Management Board, 1300 W. Michigan Street, Indianapolis, Indiana 46206 (Phone: 317–633–4420).

MARYLAND

Source Maryland Environmental Policy Act of 1973, Ch. 702, Md. Acts of 1973, 41 Ann. Code of Md., Section 447–451, (Cum. Supp. 1973), and Ch. 703, Md. Acts of 1973 Natural Res. Art., Ann. Code of Md., Section 1–301 et seq. (1974 Volume) as amended by Ch. 129 of the Md. Acts of 1975, Section 1–301(c) (effective July 1, 1975).

Guidelines "Revised Guidelines for Implementation of the Maryland Environmental Policy Act" issued by the Secretary of the Department of Natural Resources, June 15, 1974.

State Contact Paul McKee, Assistant Secretary, Department of Natural Resources, Tawes State Building, Annapolis, Maryland 21404 (Phone: 301–267–5548).

MASSACHUSETTS

Source Ch. 781, Acts of 1972, Ann. Laws Mass. Ch. 30, Section 61–62. (Cum. Supp. 1973), as amended by Ch. 257 of the Acts of 1974.

Guidelines "Regulations to Create a Uniform System for the Preparation of Environmental Impact Reports," dated July 6, 1973, as amended October 15, 1973, as amended January 8, 1975. Guidelines are prepared by the Executive Office of Environmental Affairs.

State Contact Matthew B. Connolly, Jr., Chief Planner, Executive Office of Environmental Affairs, 18 Tremont Street, Boston, Massachusetts 20488 (Phone: 617–727–2808).

MINNESOTA

Source Minnesota Environmental Policy Act of 1973, Ch. 412, Laws of 1973, Minn. Stat. Ann. Ch. 116D (Cum. Supp. 1974).

Guidelines "Rules and Regulations for Environmental Impact Statements," issued by the Minnesota Environmental Quality Council on April 4, 1974. These guidelines are presently being revised with distribution scheduled for July 1975.

State Contact Jock Robertson, Manager, Environmental Analysis Program, Environmental Quality Council, Capitol Square Building, 559 Cedar Street, St. Paul, Minnesota 55101 (Phone: 612–296–2757).

MONTANA

Source Montana Environmental Policy Act of 1971, Ch. 238, L. 1971, Rev. Code Mont., Section 69–6501, et seq. (Cum. Supp. 1973). Statute was amended in 1975 (Ch. 65, section 69–6508 and section 69–6509), but as of April 15, 1975 had not been signed into law.

Guidelines Montana Environmental Quality Council, "Revised Guidelines for Environmental Impact Statements Required by the Montana Environmental Policy Act of 1971," issued September 19, 1973.

State Contact Loren L. Bahls, PhD., Ecologist, Montana Environmental Quality Council, Capitol Station, Helena, Montana 59601 (Phone: 406–449–3742).

NEW YORK

Source New York State Environmental Quality Review Act of 1975, 8 N.Y. Environmental Conservation Law ch. 612, § 101, October 1, 1975.

Guidelines To be filed with the Secretary of State by January 1, 1976.

State Contact Stephen L. Gordon, Assistant Commissioner, Department of Environmental Conservation, 50 Wolf Road, Albany, New York 12233 (Phone: 518–457–6557).

NORTH CAROLINA

Source North Carolina Environmental Policy Act of 1971 (1971, c. 1203, s. 1), N.C. Gen. Stat. Ch. 113A (Cum. Supp. 1973).

Guidelines North Carolina Department of Administration, "Guidelines for the Implementation of the Environmental Policy Act of 1971," issued February 18, 1972.

State Contact D. Keith Whitenight, Environmental Planning Coordinator, Department of Natural and Economic Resources, P.O. Box 27687, Raleigh, North Carolina 27611 (Phone: 919–829–3838).

SOUTH DAKOTA

Source South Dakota Environmental Policy Act, SL 1974, Ch. 245 (approved March 2, 1974), S.D. Comp. Laws 1967 Ch. 11–1A (Supp. 1974).

Guidelines Department of Environmental Protection, 1974 Informal Guidelines.

State Contact Dr. Allyn O. Lockner, South Dakota Department of Environmental Protection, Office Building No. 2, Room 415, Pierre, South Dakota 57501 (Phone: 605–224–3351).

VIRGINIA

Source Virginia Environmental Policy Act of 1973, Ch. 384, Laws of 1973 (approved March 15, 1973) and Ch. 774, Laws of 1972, Va. Code Ann. Sections 10–17.107 through 10–17.112, and Sections 10–177 through 10–186 (Supp. 1973), as amended by Ch. 354, Laws of 1974 (approved April 4, 1974), Va. Code Ann. Section 2.1–51.9, Section 10.181, Section 10.183, and Section 10.185.

Guidelines Procedures Manual for Environmental Impact Statements in the Commonwealth of Virginia, issued by the Governor's Council on the Environment (December 1973; revised January 1975).

State Contact Susan T. Wilburn, Environmental Impact Statement Coordinator, Governor's Office, Council on the Environment, Eighth Street Office Building, Richmond, Virginia 23219 (Phone: 804–770–4500).

WASHINGTON

Source State Environmental Policy Act of 1971, Rev. Code Wash. Ch. 43.2C (Supp. 1973), as amended by Sub. Senate Bill 3277, Ch. 179, Laws of 1974 (May 5, 1974). NOTE: For State Highway Project Environmental Impact Report Requirements see Rev. Code Wash. Ch. 47.04 (Supp. 1973).

Guidelines Guidelines currently in use are "Guidelines for Implementation of the State Environmental Policy Act of 1971." Current guides were prepared by the Department of Ecology. Revised guides are presently being prepared.

State Contact Peter R. Haskin, Environmental Review and Evaluation, Office of Planning and Program Development, State of Washington, Department of Ecology, Olympia, Washington 98504 (Phone: 206–753–6890).

WISCONSIN

Source Wisconsin Environmental Policy Act of 1971, Ch. 274, Laws of 1971, adding Wisc. Stat. Ann. Ch. 1, Section 1.11, et seq. (Cum. Supp. 1974–1975).

Guidelines "Guidelines for the Implementation of the Wisconsin Environmental Policy Act," issued by Governor's Executive Order No. 69 (December 1973).

State Contact Farnum Alston, Office of the Governor, State Capital, Madison, Wisconsin 53703 (Phone: 608–266–7829).

PUERTO RICO

Source Puerto Rico Environmental Policy Act, 12 Laws P.R. Ann. Section 1121, et seq. (1970).

Guidelines "Guidelines for the Preparation Evaluation, and Use of Environmental Impact Statements," issued by the Environmental Quality Board on December 19, 1972.

Contact Carlos M. Jimenez Barber, Executive Director, Environmental Quality Board, 1550 Ponce de Leon Avenue, 4th Floor, Santurce, Puerto Rico 09910 (Phone: 809–725–5140).

STATES WITH COMPREHENSIVE EXECUTIVE OR ADMINISTRATIVE ORDERS

MICHIGAN

Source Michigan Executive Order 1971–10, as superseded by Michigan Executive Order 1973–9, as superseded by Michigan Executive Order 1974–4 (May 1974).

Guidelines Interim Guidelines, prepared by the Environmental Review Board and issued June 24, 1974. Revised guidelines are presently in preparation.

State Contact Terry L. Yonker, Executive Secretary, Environmental Review Board, Department of Management and Budget, Lansing, Michigan 48913 (Phone: 517-373-0933).

NEW JERSEY

Source New Jersey Executive Order No. 53 (October 15, 1973).

Guidelines "Guidelines for the Preparation of an Environmental Impact Statement," issued by the Office of the Commissioner, Department of Environmental Protection in 1973 and updated in February 1974.

State Contact Alfred Guido, Special Assistant to the Commissioner, Office of Environmental Review, Department of Environmental Protection, P.O. Box 1390, Trenton, New Jersey 08625 (Phone: 609-292-2662).

TEXAS

Source *"Policy for the Environment,"* adopted by the Interagency Council on Natural Resources and Environment on March 7, 1972, and published in *Environmental for Tomorrow: The Texas Response.* A proposed revision of the Policy was issued by the Council on March 6, 1975.

Guidelines Guidelines and procedures are contained in *Environment for Tomorrow: The Texas Response,* prepared by the Office of the Governor, Division of Planning Coordination, January 1, 1973. A proposed revision of the guidelines was issued by the Division of Planning Coordination on March 6, 1975.

State Contact Leon Wilhite, Office of the Governor, Division of Planning Coordination, Box 12428, Capital Station, Austin, Texas 78711 (Phone: 512-475-6156).

STATES WITH SPECIAL OR LIMITED EIS REQUIREMENTS

ARIZONA

Source Game and Fish Commission Policy of July 2, 1971.

Guidelines Memorandum by the Arizona Game and Fish Commission, "Requirements for Environmental Impact Statements," issued June 9, 1971.

State Contact Robert D. Curtis, Chief, Wildlife Planning and Development Division, Arizona Game and Fish Commission, 2222 W. Greenway Rd., Phoenix, Arizona 85023 (Phone: 602-942-3000).

DELAWARE

Source Delaware Coastal Zone Act, Ch. 175, Vol. 58 Laws of Del. (June 28, 1971), adding 7 Del. Code Ann. Section 7001 et seq. (Supp. 1973); Delaware Wetlands Law of 1973, adding 7 Del. Code Ann. Ch. 66 (Supp. 1973).

Guidelines a) 7 Del. Code Ann. Ch. 66, Section 6604 (Supp. 1973), and "Permit Application Instructions and Forms and Information Material on Required Procedures for the Coastal Zone Act," prepared and published by the Delaware State Planning Office, and b) Guidelines for the Wetlands Act are being prepared.

State Contacts For the Coastal Zone Act—John Sherman, Coastal Zone Administrator, State of Delaware, Executive Department Planning Office, Dover, Delaware 19901 (Phone: 302-678-4271). For the Wetlands Act—F. Michael Parkowski, Deputy Attorney General, Department of Natural

Resources and Environmental Control, Division of Environmental Control, Dover, Delaware 19901 (Phone: 302–678–4636).

GEORGIA

Source Ga. L. 1972–179 (March 10, 1972), Ga. Code Ann. Ch. 95A–1, Section 241(e)(1) (1973).

Guidelines *Policy and Procedures Manual: State Tollway Authority,* prepared by Georgia's Tollway Administrator's Office in May 1972 and revised in Feburary 1973.

State Contact Frank Harschler, Tollway Administrator, Department of Transportation, 2 Capitol Square, Atlanta, Georgia 30334 (Phone: 404–656–3915).

NEBRASKA

Source and Guidelines Nebraska Department of Roads, *Department of Roads Action Plan* (1973). This is being rewritten to meet new directives of the U.S. Department of Transportation (FHPM 771 and 772).

State Contact Robert O. Kuzelka, Comprehensive Planning Coordinator, Office of Planning and Programming, Box 94601, State Capital, Lincoln, Nebraska 68509 (Phone: 402–471–2311).

NEVADA

Source Ch. 311, Laws of 1971, 58 N.R.S. Ch. 704 (1971).

Guidelines No guidelines have been issued.

State Contact Roger S. Toundray, Director, Department of Human Resources, 308 N. Curry Street, Carson City, Nevada 80701 (Phone: 702–885–4730).

NEW JERSEY

Source Coastal Area Facility Review Act, P. L. 1973, Ch. 185 (approved June 20, 1973), N.J.S.A. 13:19–1 et seq. (Cum. Supp. 1974–1975); New Jersey Wetlands Act of 1970, Ch. 272, Laws of 1970, N.J.S.A. 13:9A–1 et seq. (Cum. Supp. 1974–1975).

Guidelines "Procedural Rules for the Administration of the Coastal Area Facilities Review Act," Draft prepared by the Department of Environmental Protection dated 1974; "New Jersey Wetlands Order: Basis and Background" issued by the New Jersey Department of Environmental Protection (April 1972). (New guidelines for this Act are presently in the late draft stage.)

State Contact Harold Barker, Chief, Bureau of Marine Lands Management, Marine Services Division, Department of Environmental Protection, P.O. Box 1889, Trenton, New Jersey 08625 (Phone: 609–292–8262).

CHAPTER 7

CEQ STUDIES

A considerable portion of the work of the Council on Environmental Quality is directed to the preparation of studies and analyses by the staff and by others under contract. Often the Council jointly funds such studies with other federal agencies. Nearly all of the work is published for use by the public. Major reports are available through the U.S. Government Printing Office; more technical analyses may be obtained from the National Technical Information Service of the Department of Commerce.* A limited number of copies is also available from the Council. What follows is a brief description of major reports made available during the past year as well as a description of a number of studies currently underway.

FLUOROCARBONS AND THE ENVIRONMENT: REPORT OF THE FEDERAL TASK FORCE ON INADVERTANT MODIFICATION OF THE STRATOSPHERE

Available from GPO.

The Council on Environmental Quality and the Federal Council for Science and Technology created the Federal Interagency Task

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*GPO=Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; NTIS=National Technical Information Service, U.S. Department of Commerce, Springfield, Va. 22151.

Force on Inadvertant Modification of the Stratosphere (IMOS) in January 1975. Any potential source of stratospheric modifications from human activities is within the group's area of study. However, the initial charge was to conduct an intensive study of possible depletion of stratospheric ozone by the manmade compounds known as fluorocarbons or "Freons" (one of its trade names).

Fluorocarbons are produced in large quantities, and ultimately almost all are released into the atmosphere. The principal uses are as aerosol propellants (50 percent) and refrigerants (28 percent). Fluorocarbons are also used as agents in the production of foams, as solvents, and as fire extinguishers. Fluorocarbons are the propellants in 50–60 percent of the approximately 3 billion aerosol units sold annually. Most that use fluorocarbons (perhaps more than 90 percent) are personal rather than household products—hair spray, deodorants, and antiperspirants. About 92 percent of U.S. refrigerants are fluorocarbon compounds; 30 percent of these, however, are a fluorocarbon that may not be of concern.

Following a 5-month intensive study, the task force issued *Fluorocarbons and the Environment,* concluding that continued release of fluorocarbons to the environment is a "legitimate cause for concern." It appears that these compounds may not be destroyed in chemical reactions in the lower atmosphere but slowly diffuse into the upper atmosphere, where upon reaching the stratosphere, they may be decomposed by ultraviolet radiation from the sun. Decomposition releases free chlorine atoms which then may act to decrease gradually the average concentration of ozone by means of catalytic chain reactions.

Ozone, a form of oxygen that exists in minor quantities in the atmosphere, is concentrated primarily in the stratosphere (between 8 and 50 kilometers) where it is maintained in a dynamic equilibrium by natural processes through which it is continually being formed and destroyed. Because the thin layer of stratospheric ozone screens the earth from harmful ultraviolet radiation, any reduction in the average long-term concentration of ozone could result in adverse effects, such as increased incidence of skin cancer.

Other possible impacts that require further investigation before definite conclusions may be drawn include: changes in physiological, biochemical, anatomical, and growth characteristics of some plant and animal species; health effects on livestock; disturbances in aquatic and terrestrial ecosystems; changes in the stability and potency of agricultural chemicals; and reduction in the yield of some crops, especially in areas of marginal agricultural production, as the result of any significant climatic changes resulting from reduction of stratospheric ozone levels. The task force concluded that unless new scientific evidence is found to remove the cause for concern, it would appear necessary to restrict uses of fluorocarbons-11 and -12 to replacement of fluids in existing refrigeration and air conditioning equipment and to closed recycled systems or other uses not involving release to the atmosphere.

Other conclusions and recommendations of the task force relate to the expected effects of any reduction in the average ozone concentration in the stratosphere, the need for labeling of aerosol products containing fluorocarbons, the present federal authorities under which various regulatory actions could be initiated, the need for toxic substances control legislation, the need for international cooperation, and the federal research program for addressing the scientific and socioeconomic issues.

The task force noted that its analysis of the relationship of fluorocarbons to stratospheric ozone reduction is presented in the general context of other possible chemicals that could behave similarly. Although by comparision fluorocarbons seem to warrant the concern expressed in this report, the IMOS task force did not attempt to reach any conclusions about other possible manmade sources of stratospheric change. They will be subjects for further studies by the task force.

Members of the task force include the major federal bodies with relevant research or regulatory responsibilities—the Departments of Agriculture; Commerce; Defense; Health, Education, and Welfare; Justice; State; and Transportation; the Consumer Product Safety Commission; Energy Research and Development Administration; Environmental Protection Agency; National Aeronautics and Space Administration; National Science Foundation; and Interdepartmental Committee for Atmospheric Sciences.

Although the report resulted from many individual task force members' contributions, it represents the collective assessment and recommendations of the group as a whole and has the full knowledge and concurrence of the agencies and groups that they represent. It is anticipated that the research and policy actions recommended in the report will be pursued by these agencies.

The report consists of an executive summary; a conclusions and federal actions section addressing the magnitude and nature of the potential problem and the proposed federal program of action; and more detailed sections treating the scientific findings concerning the stratospheric, agricultural, and biological effects of ozone reduction, human health effects, and industrial and economic considerations.

AIR POLLUTION INDICES

To be available from GPO.

Public awareness of air pollution problems has increased the need for timely information about changes in local air quality conditions. In more than one-half our large cities, millions of people receive this information every day—on television, on the radio, and in print—through various air pollution indices. A typical air pollution index interprets complex measurements of atmospheric pollutant concentrations into a single number or set of numbers in order to make the data more understandable. During the past few years, several kinds of air quality indices have been developed for purposes of summarizing long-term trends and facilitating the examination of air pollution abatement policies. However, no detailed information has been compiled on indices that are actually being used for public reporting of day-to-day air pollution levels in cities across the United States.

This study, conducted by the Council on Environmental Quality and the Environmental Protection Agency, is the first comprehensive effort to assemble a national inventory of currently used air pollution indices. It compares indices, analyzes methods of computation, and identifies problems with indices that should be brought to the attention of public officials.

The study reveals great diversity in the way that air quality conditions are reported to the public. State and local air pollution control agencies clearly seem to prefer the simpler types of indices. Nevertheless, the variety in these simpler indices is striking. Among the 33 U.S. cities and 5 states studied, there are 15 basically different types of daily air pollution indices. With two minor exceptions, *no two indices* are the same. Consistent scientific rationales have been lacking in the development of many of them.

Because of this variability, a person who travels may easily become confused about air pollution levels in different cities. In 13 cities a reported index value of 25 is accompanied by any of 10 different descriptors—from "unhealthy" to "fair" to "excellent." Striking differences are also found in the ways that cities calculate their indices, the number of pollutants that they include, and the manner in which they report their indices to the public.

The study includes an analysis of a recent attempt to adopt a common air pollution index for a three-state region. Although this proved a difficult and complex undertaking, it showed the feasibility and desirability of a single, uniform air pollution index. From the study results, it appears that the following criteria would be desirable in any such index:

- Meaningful and easily understood
- Established on a reasonable scientific basis
- Inclusive of major pollutants
- Calculated in a simple manner using reasonable assumptions
- Related to ambient air quality standards
- Able to exhibit day-to-day variations.

In July 1975, CEQ established an ad hoc Federal Interagency Task Force on Air Quality Indicators, with participation by EPA, the National Oceanic and Atmospheric Administration, and the National Bureau of Standards. Using the findings of the CEQ–EPA study as a source document, this task force is attempting to develop and implement a standard air quality index for public use.

COMPARATIVE EVALUATION OF TECHNIQUES FOR THE INTERPRETIVE ANALYSIS OF WATER QUALITY

To be available from NTIS.

In recent years, various kinds of indices, indicators, formats for data array (e.g., graphic and tabular displays), and other types of interpretive techniques related to water quality have been developed. Some of these techniques deal directly with chemical and physical water quality quantitative measures and criteria; others deal with related data on aquatic life, water uses, pollution sources, public perceptions, and other aspects of water quality. But most have not become widely utilized by government agencies to inform the public in spite of the apparent need for such techniques.

Accurate and timely information about water quality conditions and trends allows decisions about environmental regulations and planning to be made on a more informed basis. Although many of the present water quality data acquisition programs are important and valuable, the interpretation of their results usually requires considerable technical training and experience. Meanwhile, the general public and many decisionmakers in government and industry need to be supplied with understandable assessments of the significance of these data so that feasible options and their consequences may be better appreciated by those who must make them.

Because a directly measurable characteristic called "water quality" does not exist, data must be obtained and interpreted for the individual quantitative measures—such as dissolved oxygen, BOD loadings, macrobenthos diversity, or public beach closings—which are in various ways related to water quality. In order to form and communicate judgments about water quality conditions and trends, these data must be valid, accurate, and representative, and a number of scientific and socioeconomic decisions must be made about how to weigh or array them in our interpretations. Accuracy and representativeness may mean that they become understandable only to persons with specialized technical training. On the other hand, efforts to simplify may sacrifice the utility of the information to some decisionmakers and may even provide facts that mislead the public.

This study is being funded by CEQ, the Environmental Protection Agency, and the U.S. Geological Survey to help select the best available techniques for periodic water quality analysis and reporting. The primary objective of the study is to conduct comprehensive, rigorously structured, real data tests and comparative performance evaluations of a number of interpretive techniques in several categories. It also attempts to identify the applications and limitations of various techniques and the specific information needs that must be served by them.

The study is being performed by the Energy Resources Company, Inc., Mathematica, Inc., and the Bendix Corporation.

ENERGY ALTERNATIVES: A COMPARATIVE ANALYSIS and MERES AND THE EVALUATION OF ENERGY ALTERNATIVES

Available from GPO.

The Matrix of Environmental Residuals for Energy Systems—MERES—was described in some detail in last year's Annual Report. It is a computerized data base specifying the water pollution, air pollution, solid waste, land use, and occupational health effects of present and future energy systems.

Building upon the MERES data, the Science and Public Policy Program of the University of Oklahoma demonstrates use of the systems approach to environmental analysis of energy activities in *Energy Alternatives: A Comparative Analysis*. This study was sponsored by CEQ, the Energy Research and Development Administration, the Environmental Protection Agency, the Federal Energy Administration, the Federal Power Commission, the Department of the Interior, and the National Science Foundation.

A major reason for developing MERES and preparing *Energy Alternatives* is to simplify agency preparation and review of environmental impact statements for energy-related projects. These tools provide a readily available and uniform frame of reference for both the technology descriptions and environmental assessment of alternative energy sources or systems. Using these tools will allow agencies to shorten and improve environmental impact statements and to concentrate on the effects of specific projects or programs and a range of alternatives.

The first part of the study contains in-depth descriptions of the technology, environmental impacts, and economics of 11 resource systems—coal, oil shale, oil, natural gas, tar sands, nuclear fission, nuclear fusion, geothermal, hydroelectric, organic waste, and solar. It also describes electric power generation and energy end use consumption. In addition to discussing the resources and development techniques, each resource system description contains data on energy efficiencies, environmental residuals, and economic costs.

The second part illustrates how MERES data may be used to compare specified energy alternatives. It quantifies the residuals, efficiencies, and costs of a Synthane high-Btu coal gasification project and of several technological, locational, and fuel source alternatives. The hypothetical plant is adjacent to a coal mine in Montana and the synthetic natural gas transported to Seattle by pipeline. The energy alternatives evaluated were:

- A technological alternative—using a Lurgi gasifier
- A locational alternative—locating the plant in the Seattle metropolitan area and transporting the coal to it by unit train
- Several fuel source and transportation alternatives
    - Alaskan natural gas transported by pipeline from the North Slope to Valdez and by LNG tanker from Valdez to Seattle

- Alaskan natural gas delivered to the upper Midwest by pipeline through Canada (it is assumed that this alternative would displace pipeline quality gas from other sources currently serving the upper Midwest and that equivalent volumes could be supplied to the Seattle area from one of these sources)
- Increased domestic natural gas production from the California outer continental shelf delivered to Seattle by pipeline
- Imported liquefied natural gas.

ENERGY SUPPLY/DEMAND ALTERNATIVES FOR THE APPALACHIAN REGION

Available from NTIS. Executive summary, PB-242 944; complete report, PB-244 621.

A WESTERN REGIONAL ENERGY DEVELOPMENT STUDY: PRIMARY ENVIRONMENTAL IMPACTS

Available from NTIS. Vol. I, PB-246 264; Vol. II, PB-246 265; Appendices, PB-246 266; Executive Summary, PB-246 267.

A WESTERN REGIONAL ENERGY DEVELOPMENT STUDY: ECONOMICS

To be available from NTIS.

Most studies focus on the energy deficiences and related problems of the entire nation, but the problems—and the choices that are open to us—are not strictly national. Indeed, because most regions of the country have either more or less energy resources than they need, energy policy will differ among regions. Regional energy requirements, then, combine with regional impacts and regional viewpoints in the development of a national energy policy.

The Appalachian Regional Commission and the National Science Foundation joined with CEQ to contract with Resource Planning Associates, Inc., to develop a method of analyzing the economic, social, and environmental tradeoffs of national and regional energy policies. The first step was to design a computer model that would be useful in assessing the regional impacts of energy supply-demand scenarios. Appalachia was chosen because it produces far more coal than it can use and uses oil and natural gas products from outside the region.

The analytic framework makes it possible to examine four major aspects of regional supply and demand for 1985 and 2000:

- Fuel requirements of the industrial, residential, commercial, and transportation sectors

- Coal production requirements resulting from regional and extra-regional needs
- Socioeconomic and environmental impacts
- Infrastructure requirements (schools, medical facilities, and other such services).

Our experience with the Appalachian region was useful in planning a study of the Western United States—Arizona, Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming—an area that contains coal, oil, natural gas, oil shale, tight gas sands, tar sands, uranium, and geothermal resources. These multiple energy resources present development choices and opportunities to consider environmental, economic, and social tradeoffs. Work is being sponsored by the Council on Environmental Quality, Energy Research and Development Administration, Environmental Protection Agency, Federal Energy Administration, Department of the Interior, and National Science Foundation.

Radian Corporation has examined the primary environmental impacts of 38 energy resource development scenarios—that is, the air and water emissions, the solid waste, and the land requirements of a plant or process. Projections are also made of the ground level ambient concentrations of pollutants; these projections are compared with federal and state air quality standards. The scenarios include all aspects of development—extraction, conversion, and transportation to the point of end use. A representative scenario, for example, may involve the surface mining of coal from the Four Corners area of New Mexico, mine mouth electric power generation, and transmission of the power to Chicago.

The study also surveys the energy resources of the seven states, estimates energy demand patterns in seven cities, and discusses the water requirements, energy efficiency, and technological feasibility of the different scenarios.

Under another contract, Stanford Research Institute examined the economics of these same scenarios. The capital investments and operating costs for extracting, converting, and transporting all forms of energy were subjected to a comprehensive review. These data were placed in a computer model, along with a projection of U.S. energy demand to the year 2000. National and regional estimates of energy supply, including synthetic fuels, were calculated by the model (see the Energy Technology section of Chapter 3 and the Energy Facility Siting section of Chapter 4).

Finally, the socioeconomic and secondary (induced) environmental impacts are being examined. The Denver Research Institute is the principal contractor. Under the aegis of the Council on Environmental Quality, an interagency committee will be formed to manage the project. It will examine methodologies for projecting socioeconomic impacts and will recommend an approach for evaluating the socioeconomic impacts of these western energy development scenarios.

SUBDIVIDING RURAL AMERICA: IMPACTS OF RECREATIONAL LOT AND LEISURE HOME DEVELOPMENT

To be available from GPO.

This 2-year study of leisure homes and other recreational properties, completed during the past year, was funded by CEQ, the Department of Housing and Urban Development, and the Appalachian Regional Commission. The main study, *Subdividing Rural America: Impacts of Recreational Lot and Leisure Home Development,* analyzes in detail the extent of and present trends in the market for recreational lots and leisure homes; the economic, environmental, and social impacts of recreational development; and federal, state, and local regulations affecting these markets. A separate *Executive Summary* summarizes the findings and presents recommendations on how the adverse impacts of recreational developments can be better controlled. A third volume, *Recreational Lot and Leisure Home Developments: A Manual for Reviewing Impacts,* provides guidelines to assist developers and local officials in evaluating the potential impacts of new developments.

Three additional study outputs are available from other sources, as follows:

- *Recreational Properties: An Analysis of the Markets for Privately Owned Recreational Lots and Leisure Homes,* by Richard L. Ragatz Associates, Inc. (May 1974). This nationwide study of the recreational properties market is available from NTIS (PB–233 148) or directly from the author at 3660 Donald Street, Eugene, Oregon. A highly condensed version of the data appears in the full report of the study group.
- *Recreational Properties in Appalachia: An Analysis of Markets for Privately Owned Recreational Lots and Leisure Homes,* by Richard L. Ragatz Associates, Inc. (September 1974). This market study deals specifically with recreational properties in the Appalachian states; it is available from NTIS (PB–233 148).
- *The Subdivision of Virginia's Mountains: The Environmental Impact of Recreational Subdivisions in the Massanutten Mountain-Blue Ridge Area, Virginia,* by William E. Shands, published by the Conservation Foundation (February 1974). This report on the environmental impacts of recreational subdivisions in Virginia is available from the Conservation Foundation, 1717 Massachusetts Avenue, N.W., Washington, D.C. 20036.

RECREATION AND WATER SUPPLY RESERVOIRS: A HANDBOOK FOR INCREASED USE

Available from GPO.

Near many cities lie beautiful water supply reservoirs, protected over the years by careful watershed management. In most parts of the country, recreation on and around these reservoirs is a matter of course in conjunction with full-scale treatment. Water managers accept management of recreation as part of their basic responsibility. But in six of the most populous Northeastern states—Connecticut, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island—public access to reservoirs and the surrounding lands is generally restricted or is prohibited altogether. Often the water supply receives little treatment here, so water managers feel that increased public recreation on the lands and reservoirs that they manage will degrade water quality.

Use of reservoirs was restricted in order to protect public health. Such restriction was essential in the past, but it is no longer, because new requirements for improved water treatment make recreation compatible with production of high quality drinking water. Recreation is not the reason for installing these improved water treatment systems; they are being required by legislative mandate to assure pure drinking water. Recreation is, therefore, a valuable fringe benefit accompanying the adoption of advanced treatment techniques that will soon become standard.

Urban Systems Research and Engineering, Inc., under contract with CEQ, has prepared a citizens' handbook for planning recreation on water supply reservoirs; emphasis is on those states where such recreational use is generally not now permitted but where new treatment requirements will make recreation a compatible use. It includes an inventory of reservoirs as well as the state laws and regulations that govern their use. The chapter on planning provides basic information for developing a recreation plan:

- Types of activities and required facilities
- Number and types of users
- Economics of developing and operating facilities
- Legal, social, and institutional constraints.

THE DELAWARE RIVER BASIN—AN ENVIRONMENTAL ASSESSMENT OF THREE CENTURIES OF CHANGE

Available from GPO.

Most reports of CEQ and other federal agencies look at a single issue or set of issues from a national perspective. Because of the desire to understand better how the full range of environmental concerns affects a given area, CEQ undertook an in-house study of one region. The focus is on how environmental issues are resolved in light of their conflicts with each other and with other goals and policies at work in the same region.

The Delaware River Basin was chosen for a number of reasons. First, environmental problems were early to appear there—air and water pollution, urban decay, suburban sprawl, the recreation home boom, and energy facility development are all old and familiar issues in the region although attitudes about them have changed in recent years as much as elsewhere. Second, serious conflicts over limited land and water resources have already begun to appear in the basin, and especially in the bay area where recreation, commercial fishing, and energy development try to coexist. Third, the Delaware Basin provides a wide variety of environments with forested mountains, checkerboard farmlands, urban industrial complexes, extensive wetlands, and fishing villages. Finally, cooperation among states, localities, and citizens in the region has resulted in ideas and arrangements for problem-solving that could be useful elsewhere.

Following a discussion of the geography and history of the region are chapters on the uses of the river itself; progress on air pollution abatement, with a description of Philadelphia's efforts; an analysis of urban environmental issues, with the focus on Trenton; a review of suburban growth trends based on the Bucks County experience; a look at the recreational land boom in the Poconos; and a report on the forces of change at work in the Bay country. The report concludes with an estimate of progress on improving the environment of the region and identifies what remains to be done. To a large extent, the report points out, the key issues that remain to be resolved have a common land use thread—whether the problem is controlling water pollution from urban runoff, reducing auto dependency to improve air quality, reviving the cities, preserving farmland, protecting the mountains from subdivision and sale, or deciding where to put the next refinery. The ability of states and localities to come to grips with this realization and to establish effective, coordinated programs and policies that make environmental goals compatible is critical to the future quality of life in the basin.

THE IMPACT OF DIFFERENTIAL ASSESSMENT OF FARM AND OPEN LAND

To be available from GPO.

All across the country, rural land values and tax rates have been rising as urbanization moves out from the city to undeveloped areas. As this occurs, land increases in value over and above its farm use value because it can be used or has a potential for residential, commercial, and industrial purposes. Tax rates rise because the new residents of the rural-urban fringe demand schools, water and sewer systems, roads, police protection, and other public services that were previously unnecessary. Caught in the double crunch of paying taxes at higher rates on land whose market value is rising, farmers and other owners of undeveloped land have sought to have their land assessed for real property tax purposes at its current or farm use value rather than at its fair market value, which often includes a substantial element of development value.

Since 1957, when Maryland enacted the first statute authorizing differential assessment of farmland, 41 state legislatures have passed laws which granted preferential treatment to farm or other types of undeveloped land. Most of the remaining states either have so-called classification laws which allow modest preferential treatment of agricultural land or are currently considering differential assessment legislation. These laws were enacted under the banners of preserving open space and of easing the tax burdens of farmers. The fundamental principle on which they were based was that by reducing property taxes, the rate at which farmland was being converted to nonfarm uses could be significantly decreased.

To test the effectiveness of differential tax laws in accomplishing these farm and open space preservation goals, CEQ funded a study by the University of Pennsylvania. The study shows that acting alone, most laws do little more than delay for a few years the decision to sell the land or to develop it. Nonetheless, when combined with other effective land use mechanisms, differential assessment can contribute to successful long-term preservation of open lands. In the course of this evaluation, many other aspects of differential assessment were also examined.

Both the complete report and an executive summary will be available. The complete report is divided into two major parts. Part I consists of five chapters presenting the general findings and conclusions. The history and characteristics of differential assessment laws are reviewed. They are then evaluated in terms of providing tax benefits to farmers and other owners of eligible undeveloped land and as tools for maintaining current use of such land. The fifth chapter is an evaluation of their equity, ease of administration, and political feasibility. Finally, the general conclusions and recommendations of the report are presented.

Part Two consists of ten special analyses and an annotated bibliography. The general relationships among supply and demand factors in the land market at the rural-urban fringe, including real property taxes, are followed by detailed studies of differential assessment programs in California, Connecticut, Hawaii, Indiana, Maryland, New Jersey, New York, Oregon, and Washington. These states were chosen because they have had significant experience with differential assessment, they are experiencing urbanization, and their laws embodied representative approaches.

THE GROWTH SHAPERS—LAND USE IMPACTS OF INFRASTRUCTURE INVESTMENTS

To be available from GPO.

This study summarizes in a readily understandable manner the land use effects of infrastructure investments; the resulting economic, environmental, and social impacts of these effects; and land use regulations that local governments may adopt to control these impacts. The report discusses the factors that influence the magnitude and pattern of the land development that follows infrastructure investments and the seriousness of the resulting impacts. The analysis concentrates on the impacts of highways, sewers, and mass transit and then covers in less detail such other investments as airports, employment centers, recreational facilities, and dams. The report was prepared for the Council by Urban Systems Research and Engineering, Inc.

NATIONAL INVENTORY OF BIOLOGICAL MONITORING PROGRAMS

To be available from NTIS.

Biological monitoring data are essential for decisionmaking related to our living resources. Within the United States, there are many projects collecting such data. A source of coordinated information concerning the purpose and scope of these projects and the availability of their data does not exist. The Environmental Sciences Division of Oak Ridge National Laboratory is conducting a nationwide inventory of such projects under the auspices of CEQ, the National Marine Fisheries Service, the Energy Research and Development Administration, and the U.S. Fish and Wildlife Service. The Institute of Ecology is participating in an advisory capacity.

The information gathered will be assembled into a computer data base, which will facilitate the systematic and readily accessible use of information from biological monitoring projects throughout the United States.

For purposes of this project, biological monitoring is defined as any data collection in which living organisms are systematically and continuously or periodically studied. Investigations that result in the identification of a well-defined population change over time are especially desired. Interest also extends to new programs that may identify such future trends as well as to programs that have already identified important trends.

THE ROLE OF ECOLOGY IN THE FEDERAL GOVERNMENT

Available from CEQ and FCST.

This document presents a first assessment of the extent and status of ecological research carried out by federal agencies. It was prepared by an Ad Hoc Committee on Ecological Research chartered by the Council on Environmental Quality and the Federal Council for Science and Technology.

Ecological knowledge is basic to the operations of many federal agencies as well as to the effective implementation of the National Environmental Policy Act. The research is undertaken by many federal agencies in connection with their primary missions. Until now there had been no inventory or evaluation of the research or of the government's need for it. Accordingly, in 1972 a committee of government scientists, aided by ecologists from the nongovernment scientific community, was established to examine these questions and make recommendations.

As an initial attempt to address the role of the federal government, the committee was requested to identify the national needs for ecology, to assess the present state of our capabilities and efforts to meet these needs, and to recommend long- and short-range federal actions to provide the ecological knowledge and know-how basic to achieving national goals. A corollary purpose emerging from committee efforts was to provide a focus for the diverse federal activities and specialized fields, both to promote better coordination, understanding, and utilization of what is underway and to facilitate identification of needs.

APPENDIX A

ORGANIZATION AND STAFF OF THE COUNCIL ON ENVIRONMENTAL QUALITY

THE COUNCIL

Russell W. Peterson was sworn in as Chairman of the Council on November 30, 1973. From 1969 to 1973 he was Governor of Delaware. From 1942 to 1968, Chairman Peterson was with the DuPont Company. In 1971 he was named Conservationist of the Year by the National Wildlife Federation and given the Gold Medal Award by the World Wildlife Fund.

John A. Busterud and Dr. Beatrice E. Willard are the other Members of the Council, both appointed in 1972. Mr. Busterud was Deputy Assistant Secretary of Defense for Environmental Quality from 1971 to 1972. Prior to this, he practiced law with a San Francisco firm specializing in conservation and antitrust law. He was a member of the Assembly in the California legislature.

Dr. Willard, an ecologist, is former President of the Thorne Ecological Institute of Boulder, an ecology center for industrial and government decisionmakers. She has served as Secretary of the Colorado Air Pollution Control Commission. She has been a professor of biology at the University of Colorado and is the author of books on alpine ecosystems.

THE COUNCIL STAFF

The Council's staff is primarily responsible for developing policy proposals through legislation, special reports, task forces, and other means. It also assists in the coordination of federal environmental policy. The staff is responsible for review and evaluation of federal activities which have a potential effect on the environment and for policy development relating to such activities. Steven D. Jellinek is Staff Director and William Matuszeski is Assistant Staff Director. Malcolm F. Baldwin, Paul F. Bente, Jr., Edwin H. Clark, Charles Eddy, Barry R. Flamm, and Warren R. Muir are Senior Staff Members. Staff Members are Gerald L. Brubaker, Katherine B. Gillman, Warren T. Greenleaf, Lawrence W. Hill, Michael J. Kane, Marilyn W. Klein, Mary Jane S. Markley, Sheila A. Mulvihill, Katherine B. Penn, James J. Reisa, Jr., Richard B. Sheppard, Marvin I. Singer, Robert B. Smythe, Marion P. Suter, and Peter Winkel.

GENERAL COUNSEL

The General Counsel's Office is responsible for review of legislative and regulatory matters coming before the Council, specifically with regard to the interpretation and implementation of the National Environmental Policy Act.

Gary L. Widman, General Counsel to the Council, is assisted by David B. Cook, Constance K. Lundberg, and David Tundermann.

ADVISORS

Technical advisors on the Council staff provide expertise in the areas of science and international affairs. They are Lee M. Talbot, Assistant to the Chairman for International and Scientific Affairs, and Earl H. Lubensky, Senior Staff Member for International Affairs, who is on detail from the Department of State. Gerard A. Bertrand is an assistant to Dr. Talbot and James J. Mandros, on detail from the U.S. Information Agency, is an assistant to Mr. Lubensky.

ADMINISTRATIVE STAFF

John R. Fogarty is Public Information Officer, Willis G. Savage is Administrative Officer, and Bernice Carney is Assistant Administrative Officer.

SUPPORTIVE STAFF

Florence L. Broussard, Ruth W. Nefflen, and Marjory D. Bianchi are executive assistants to the Chairman, Mr. Busterud, and Dr. Willard respectively. Other staff members are: Eugene H. Able, Julia Alessio, Margaret C. Battle, Janet L. Bearden, Vicki L. Boyd, Yvonne R. Countee, Joyce M. Cox, Odelia L. Doggette, Margaret M. Gugino, Anna M. Klocke, Sally Mallison, Muriel L. Montgomery, Janet A. Peck, Helen Z. Rebholz, Barbara E. Sergeant, William Whitehouse, Gayle M. Wilkins, and Norma L. Williams.

INTERNS

Murray F. Abbott, Principia College; Craig Avery, Hamilton College; Leslie A. Baldwin, Vassar College; William E. Booth, Worcester Polytechnic Institute; William R. Brandt, Jr., Principia College; William Y. Brown, Harvard Law School; James A. Buffi, Worcester Polytechnic Institute; Jeffrey E. Burek, Worcester Polytechnic Institute; Zoraida J. Carballeira, Environmental Protection Agency; Paul C. Carubia, Worcester Polytechnic Institute; Thomas Cator, George Washington University; Candyce E. Clark, Mount Holyoke College; Heather L. Coleman, George Washington University National Law Center; Carl L. Cook, Jr., Department of Housing and Urban Development; Richard P. Cote, Worcester Polytechnic Institute; Veronica Davis, Department of Housing and Urban Development; Marcia E. Downs, Olivet College; John D. Echeverria, Yale University; David A. Emil, Columbia Law School; Eric Erdheim, George Washington University National Law Center; Anthony J. Giglio, Worcester Polytechnic Institute; Maureen Grimmer, Notre Dame Law School; Robert D. Jamieson, Worcester Polytechnic Institute; Jody R. Katz, Cornell University; Brian D. Kisiel, Worcester Polytechnic Institute; Lawrence N. Koppelman, Massachusetts Institute of Technology; Julie Lee, George Washington University; Lucinda Low, University of California at Riverside; Gregory R. McConnell, Howard University Law School; Marilyn A. Marlek, Georgetown Law School; Barbara K. Polich, University of Wisconsin Law School; Ann E. Prezyna, George Washington University National Law Center; Benjamin C. Rosko, New York University Law School; Phillip L. Schulman, Northeastern Law School; John J. Schwonke, Wharton School of Business; Robert Slomski, University of California at Los Angeles; Morris L. Weisman, Worcester Polytechnic Institute; Melissa M. Weiksnar, Wellsley College; Mario Wunderlich, Jr., Worcester Polytechnic Institute.

THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969, AS AMENDED*

An Act to establish a national policy for the environment, to provide for the establishment of a Council on Environmental Quality, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Environmental Policy Act of 1969."

PURPOSE

SEC. 2. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

TITLE I

DECLARATION OF NATIONAL ENVIRONMENTAL POLICY

SEC. 101. (a) The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may—

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*Pub. L. 91–190, 42 U.S.C. 4321–4347, January 1, 1970, as amended by Pub. L. 94–83, August 9, 1975.

(1) Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

(2) Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasuring surroundings;

(3) Attain the widest range of beneficial uses of the environment *without degradation, risk to health* or safety, or other undesirable and unintended consequences;

(4) Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice;

(5) Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

Sec. 102. The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the Federal Government shall—

(A) Utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment;

(B) Identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropirate consideration in decisionmaking along with economic and technical considerations;

(C) Include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on—

(i) The environmental impact of the proposed action,

(ii) Any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) Alternatives to the proposed action,

(iv) The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Prior to making any detailed statement, the responsible Federal official shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved. Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public as provided by section 552 of title 5, United States Code, and shall accompany the proposal through the existing agency review processes;

(D) Any detailed statement required under subparagraph (C) after January 1, 1970, for any major Federal action funded under a program of grants to States shall not be deemed to be legally insufficient solely by reason of having been prepared by a State agency or official, if:

(i) the State agency or official has statewide jurisdiction and has the responsibility for such action,

(ii) the responsible Federal official furnishes guidance and participates in such preparation,

(iii) the responsible Federal official independently evaluates such statement prior to its approval and adoption, and

(iv) after January 1, 1976, the responsible Federal official provides early notification to, and solicits the views of, any other State or any Federal land management entity of any action or any alternative thereto which may have significant impacts upon such State or affected Federal land management entity and, if there is any disagreement on such impacts, prepares a written assessment of such impacts and views for incorporation into such detailed statement.

The procedures in this subparagraph shall not relieve the Federal official of his responsibilities for the scope, objectivity, and content of the entire statement or of any other responsibility under this Act; and further, this subparagraph does not affect the legal sufficiency of statements prepared by State agencies with less than statewide jurisdiction.

(E) Study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;

(F) Recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment;

(G) Make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;

(H) Initiate and utilize ecological information in the planning and development of resource-oriented projects; and

(I) Assist the Council on Environmental Quality established by title II of this Act.

SEC. 103. All agencies of the Federal Government shall review their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this Act and shall propose to the President not later than July 1, 1971, such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this Act.

SEC. 104. Nothing in section 102 or 103 shall in any way affect the specific statutory obligations of any Federal agency (1) to comply with criteria or standards of environmental quality, (2) to coordinate or consult with any other Federal or State agency, or (3) to act, or refrain from acting contingent upon the recommendations or certification of any other Federal or State agency.

SEC. 105. The policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies.

TITLE II

COUNCIL ON ENVIRONMENTAL QUALITY

SEC. 201. The President shall transmit to the Congress annually beginning July 1, 1970, an Environmental Quality Report (hereinafter referred to as the "report") which shall set forth (1) the status and condition of the major natural, manmade, or altered environmental classes of the Nation, including, but not limited to, the air, the aquatic, including marine, estuarine, and fresh water, and the terrestrial environment, including, but not limited to, the forest, dryland, wetland, range, urban, suburban and rural environment; (2) current and foreseeable trends in the quality, management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the Nation; (3) the adequacy of available natural resources for fulfilling human and economic requirements of the Nation in the light of expected population pressures; (4) a review of the programs and activities (including regulatory activities) of the Federal Government, the State and local governments, and nongovernmental entities or individuals with particular reference to their effect on the environment and on the conservation, development and utilization of natural resources; and (5) a program for remedying the deficiencies of existing programs and activities, together with recommendations for legislation.

SEC. 202. There is created in the Executive Office of the President a Council on Environmental Quality (hereinafter referred to as the "Council"). The Council shall be composed of three members who shall be appointed by the President to serve at his pleasure, by and with the advice and consent of the Senate. The President shall designate one of the members of the Council to serve as Chairman. Each member shall be a person who. as a result of his training, experience, and attainments, is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the Federal Government in the light of the policy set forth in title I of this Act; to be conscious of and responsive to the scientific, economic, social, esthetic, and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality of the environment.

SEC. 203. The Council may employ such officers and employees as may be necessary to carry out its functions under this Act. In addition, the Council may employ and fix the compensation of such experts and consultants as may be necessary for the carrying out of its functions under this Act, in accordance with section 3109 of title 5, United States Code (but without regard to the last sentence thereof).

SEC. 204. It shall be the duty and function of the Council—

(1) To assist and advise the President in the preparation of the Environmental Quality Report required by section 201;

(2) To gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in title I of this Act, and to compile and submit to the President studies relating to such conditions and trends;

(3) To review and appraise the various programs and activities of the Federal Government in the light of the policy set forth in title I of this Act for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto;

(4) To develop and recommend to the President national policies to foster and promote the improvement of environmental quality to meet the conservation, social, economic, health, and other requirements and goals of the Nation;

(5) To conduct investigations, studies, surveys, research, and analyses relating to ecological systems and environmental quality;

(6) To document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary

data and other information for a continuing analysis of these changes or trends and an interpretation of their underlying causes;

(7) To report at least once each year to the President on the state and condition of the environment; and

(8) To make and furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the President may request.

SEC. 205. In exercising its powers, functions, and duties under this Act, the Council shall—

(1) Consult with the Citizens' Advisory Committee on Environmental Quality established by Executive Order No. 11472, dated May 29, 1969, and with such representatives of science, industry, agriculture, labor, conservation organizations, State and local governments and other groups, as it deems advisable; and

(2) Utilize, to the fullest extent possible, the services, facilities and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the Council's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies.

SEC. 206. Members of the Council shall serve full time and the Chairman of the Council shall be compensated at the rate provided for Level II of the Executive Schedule Pay Rates (5 U.S.C. 5313). The other members of the Council shall be compensated at the rate provided for Level IV of the Executive Schedule Pay Rates (5 U.S.C. 5315).

SEC. 207. There are authorized to be appropriated to carry out the provisions of this Act not to exceed $300,000 for fiscal year 1970, $700,000 for fiscal year 1971, and $1 million for each fiscal year thereafter.

Approved January 1, 1970.

THE ENVIRONMENTAL QUALITY IMPROVEMENT ACT OF 1970*

TITLE II—ENVIRONMENTAL QUALITY (OF THE WATER QUALITY IMPROVEMENT ACT OF 1974)

SHORT TITLE

SEC. 201. This title may be cited as the "Environmental Quality Improvement Act of 1970."

FINDINGS, DECLARATIONS, AND PURPOSES

SEC. 202. (a) The Congress finds—

(1) That man has caused changes in the environment;

(2) That many of these changes may affect the relationship between man and his environment; and

(3) That population increases and urban concentration contribute directly to pollution and the degradation of our environment.

(b)(1) The Congress declares that there is a national policy for the environment which provides for the enhancement of environmental quality. This policy is evidenced by statutes heretofore enacted relating to the prevention, abatement, and control of environmental pollution, water and land resources, transportation, and economic and regional development.

(2) The primary responsibility for implementing this policy rests with State and local governments.

(3) The Federal Government encourages and supports implementation of this policy through appropriate regional organizations established under existing law.

(c) The purposes of this title are—

(1) To assure that each Federal department and agency conducting or supporting public works activities which affect the environment shall implement the policies established under existing law; and

(2) To authorize an Office of Environmental Quality, which, notwithstanding any other provision of law, shall provide the professional and administrative staff for the Council on Environmental Quality established by Public Law 91–190.

OFFICE OF ENVIRONMENTAL QUALITY

SEC. 203. (a) There is established in the Executive Office of the President an office to be known as the Office of Environmental Quality (hereafter in this title referred to as the "Office"). The Chairman of the Council on Environmental Quality established by Public Law 91–190 shall be the Director of the Office. There shall be in the Office a Deputy Director who shall be appointed by the President, by and with the advice and consent of the Senate.

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*Pub. L. 91–224, 42 U.S.C. 4371–4374, April 3, 1970.

(b) The compensation of the Deputy Director shall be fixed by the President at a rate not in excess of the annual rate of compensation payable to the Deputy Director of the Bureau of the Budget.

(c) The Director is authorized to employ such officers and employees (including experts and consultants) as may be necessary to enable the Office to carry out its functions under this title and Public Law 91–190, except that he may employ no more than 10 specialists and other experts without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, and pay such specialists and experts without regard to the provisions of chapter 51 and subchapter 111 of chapter 53 of such title relating to classification and General Schedule pay rates, but no such specialist or expert shall be paid at a rate in excess of the maximum rate for GS–18 of the General Schedule under section 5330 of title 5.

(d) In carrying out his functions the Director shall assist and advise the President on policies and programs of the Federal Government affecting environmental quality by—

(1) Providing the professional and administrative staff and support for the Council on Environmental Quality established by Public Law 91–190;

(2) Assisting the Federal agencies and departments in appraising the effectiveness of existing and proposed facilities, programs, policies, and activities of the Federal Government, and those specific major projects designated by the President which do not require individual project authorization by Congress, which affect environmental quality;

(3) Reviewing the adequacy of existing systems for monitoring and predicting environmental changes in order to achieve effective coverage and efficient use of research facilities and other resources;

(4) Promoting the advancement of scientific knowledge of the effects of actions and technology on the environment and encourage the development of the means to prevent or reduce adverse effects that endanger the health and well-being of man;

(5) Assisting in coordinating among the Federal departments and agencies those programs and activities which affect, protect, and improve environmental quality;

(6) Assisting the Federal departments and agencies in the development and interrelationship of environmental quality criteria and standards established through the Federal Government;

(7) Collecting, collating, analyzing, and interpreting data and information on environmental quality, ecological research, and evaluation.

(e) The Director is authorized to contract with public or private agencies, institutions, and organizations and with individuals without regard to sections 3618 and 3709 of the Revised Statutes (31 U.S.C. 529; 41 U.S.C. 5) in carrying out his functions.

REPORT

Sec. 204. Each Environmental Quality Report required by Public Law 91–190 shall, upon transmittal to Congress, be referred to each standing committee having jurisdiction over any part of the subject matter of the Report.

AUTHORIZATION

Sec. 205. There are hereby authorized to be appropriated not to exceed $500,000 for the fiscal year ending June 30, 1970, not to exceed $750,000 for the fiscal year ending June 30, 1971, not to exceed $1,250,000 for the fiscal year ending June 30, 1972, and not to exceed $1,500,000 for the fiscal year ending June 30, 1973. These authorizations are in addition to those contained in Public Law 91–190.

Approved April 3, 1970.

APPENDIX D

EXECUTIVE ORDER 11514, PROTECTION AND ENHANCEMENT OF ENVIRONMENTAL QUALITY*

By virtue of the authority vested in me as President of the United States and in furtherance of the purpose and policy of the National Environmental Policy Act of 1969 (Public Law No. 91–190, approved January 1, 1970), it is ordered as follows:

SEC. 1. *Policy.* The Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Federal agencies shall initiate measures needed to direct their policies, plans and programs so as to meet national environmental goals. The Council on Environmental Quality, through the Chairman, shall advise and assist the President in leading this national effort.

SEC. 2. *Responsibilities of Federal Agencies.* Consonant with Title I of the National Environmental Policy Act of 1969, hereinafter referred to as the "Act," the heads of Federal agencies shall:

(a) Monitor, evaluate, and control on a continuing basis their agencies' activities so as to protect and enhance the quality of the environment. Such activities shall include those directed to controlling pollution and enhancing the environment and those designed to accomplish other program objectives which may affect the quality of the environment. Agencies shall develop programs and measures to protect and enhance environmental quality and shall assess progress in meeting the specific objectives of such activities. Heads of agencies shall consult with appropriate Federal, State and local agencies in carrying out their activities as they affect the quality of the environment.

(b) Develop procedures to ensure the fullest practicable provision of timely public information and understanding of Federal plans and programs with environmental impact in order to obtain the views of interested parties. These procedures shall include, whenever appropriate, provision for public hearings, and shall provide the public with relevant information, including information on alternative courses of action. Federal agencies shall also encourage State and local agencies to adopt similar procedures for informing the public concerning their activities affecting the quality of the environment.

(c) Insure that information regarding existing or potential environment problems and control methods developed as part of research, development, demonstration, test, or evaluation activities is made available to Federal agencies, States, counties, municipalities, institutions, and other entities, as appropriate.

(d) Review their agencies' statutory authority, administering regulations, policies, and procedures, including those relating to loans, grants, contracts, leases, licenses, or permits, in order to identify any deficiencies or inconsistencies therein which prohibit or limit full compliance with the purposes and provisions of the Act. A report on this review and the corrective actions taken or planned, including such measures to be proposed to the President as may be necessary to bring their authority and policies into conformance with the intent, purposes, and procedures of the Act, shall be provided to the Council on environmental Quality not later than September 1, 1970.

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*March 5, 1970.

(e) Engage in exchange of data and research results, and cooperate with agencies of other governments to foster the purposes of the Act.

(f) Proceed, in coordination with other agencies, with actions required by section 102 of the Act.

SEC. 3. *Responsibilities of Council on Environmental Quality.* The Council on Environmental Quality shall:

(a) Evaluate existing and proposed policies and activities of the Federal Government directed to the control of pollution and the enhancement of the environment and to the accomplishment of other objectives which affect the quality of the environment. This shall include continuing review of procedures employed in the development and enforcement of Federal standards affecting environmental quality. Based upon such evaluations the Council shall, where appropriate, recommend to the President policies of environmental quality and shall, where appropriate, seek resolution of significant environmental issues.

(b) Recommend to the President and to the agencies priorities among programs designed for the control of pollution and for enhancement of the environment.

(c) Determine the need for new policies and programs for dealing with environmental problems not being adequately addressed.

(d) Conduct, as it determines to be appropriate, public hearings or conferences on issues of environmental significance.

(e) Promote the development and use of indices and monitoring systems (1) to assess environmental conditions and trends, (2) to predict the environmental impact of proposed public and private actions, and (3) to determine the effectiveness of programs of protecting and enhancing environmental quality.

(f) Coordinate Federal programs related to environmental quality.

(g) Advise and assist the President and the agencies in achieving international cooperation for dealing with environmental problems, under the foreign policy guidance of the Secretary of State.

(h) Issue guidelines to Federal agencies for the preparation of detailed statements on proposals for legislation and other Federal actions affecting the environment, as required by section 102(2)(C) of the Act.

(i) Issue such other instructions to agencies, and request such reports and other information from them, as may be required to carry out the Council's responsibilities under the Act.

(j) Assist the President in preparing the annual Environmental Quality Report provided for in section 201 of the Act.

(k) Foster investigations, studies, surveys, research, and analyses relating to (i) ecological systems and environmental quality, (ii) the impact of new and changing technologies thereon, and (iii) means of preventing or reducing adverse effects from such technologies.

SEC. 4. *Amendments of E.O. 11472.* Executive Order No. 11472 of May 29, 1969, including the heading thereof, is hereby amended:

(1) By substituting for the term "the Environmental Quality Council", wherever it occurs, the following: "the Cabinet Committee on the Environment".

(2) By substituting for the term "the Council", wherever it occurs, the following: "the Cabinet Committee".

(3) By inserting in subsection (f) of section 101, after "Budget,", the following: "the Director of the Office of Science and Technology,".

(4) By substituting for subsection (g) of section 101 the following: "(g) The Chairman of the Council on Environmental Quality (es-

tablished by Public Law 91–190) shall assist the President in directing the affairs of the Cabinet Committee."

(5) By deleting subsection (c) of section 102.

(6) By substituting for "the Office of Science and Technology", in section 104, the following: "the Council on Environmental Quality (established by Public Law 91–190)".

(7) By substituting for "(hereinafter referred to as the 'Committee')", in section 201, the following: "hereinafter referred to as the 'Citizens' Committee')".

(8) By substituting for the term "the Committee", wherever it occurs, the following: "the Citizens' Committee".

THE WHITE HOUSE.

RICHARD NIXON.

PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS: GUIDELINES*

On May 2, 1973, the Council on Environmental Quality published in the FEDERAL REGISTER, for public comment, a proposed revision of its guidelines for the preparation of environmental impact statements. Pursuant to the National Environmental Policy Act (P.L. 91–190, 42 U.S.C. 4321 et seq.) and Executive Order 11514 (35 FR 4247) all Federal departments, agencies, and establishments are required to prepare such statements in connection with their proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. The authority for the Council's guidelines is set forth below in § 1500.1. The specific policy to be implemented by the guidelines is set forth below in § 1500.2.

The Council received numerous comments on its proposed guidelines from environmental groups, Federal, State, and local agencies, industry, and private individuals. Two general themes were presented in the majority of the comments. First, the Council should increase the opportunity for public involvement in the impact statement process. Second, the Council should provide more detailed guidance on the responsibilities of Federal agencies in light of recent court decisions interpreting the Act. The proposed guidelines have been revised in light of the specific comments relating to these general themes, as well as other comments received, and are now being issued in final form.

The guidelines will appear in the Code of Federal Regulations in Title 40, Chapter V, at Part 1500. They are being codified, in part, because they affect State and local governmental agencies, environmental groups, industry, and private individuals, in addition to Federal agencies, to which they are specifically directed, and the resultant need to make them widely and readily available.

Sec.
1500.1 Purpose and authority.
1500.2 Policy.
1500.3 Agency and OMB procedures.
1500.4 Federal agencies included: effect of the act on existing agency mandates.
1500.5 Types of actions covered by the act.
1500.6 Identifying major actions significantly affecting the environment.
1500.7 Preparing draft environmental statements; public hearings.
1500.8 Content of environmental statements.
1500.9 Review of draft environmental statements by Federal, Federal-State, State, and local agencies and by the public.
1500.10 Preparation and circulation of final environmental statements.
1500.11 Transmittal of statements to the Council; minimum periods for review; requests by the Council.

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*38 Fed. Reg. 20550–20562 (1973).

Sec.
1500.12 Legislative actions.
1500.13 Application of section 102(2)(C) procedure to existing projects and programs.
1500.14 Supplementary guidelines; evaluation of procedures.

Appendix I Summary to accompany draft and final statements.
Appendix II Areas of environmental impact and Federal agencies and Federal-State agencies with jurisdiction by law or special expertise to comment thereon.
Appendix III Offices within Federal agencies and Federal-State agencies for information regarding the agencies' NEPA activities and for receiving other agencies' impact statements for which comments are requested.
Appendix IV State and local agency review of impact statements.

AUTHORITY: National Environmental Policy Act (P.L. 91–190, 42 U.S.C. 4321 et seq.) and Executive Order 11514.

§ 1500.1 PURPOSE AND AUTHORITY

(a) This directive provides guidelines to Federal departments, agencies, and establishments for preparing detailed environmental statements on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment as required by section 102(2)(C) of the National Environmental Policy Act (P.L. 91–190, 42 U.S.C. 4321 et seq., hereafter "the Act"). Underlying the preparation of such environmental statements is the mandate of both the Act and Executive Order 11514 (35 FR 4247) of March 5, 1970, that all Federal agencies, to the fullest extent possible, direct their policies, plans and programs to protect and enhance environmental quality. Agencies are required to view their actions in a manner calculated to encourage productive and enjoyable harmony between man and his environment, to promote efforts preventing or eliminating damage to the environment and biosphere and stimulating the health and welfare of man, and to enrich the understanding of the ecological systems and natural resources important to the Nation. The objective of section 102(2)(C) of the Act and of these guidelines is to assist agencies in implementing these policies. This requires agencies to build into their decisionmaking process, beginning at the earliest possible point, an appropriate and careful consideration of the environmental aspects of proposed action in order that adverse environmental effects may be avoided or minimized and environmental quality previously lost may be restored. This directive also provides guidance to Federal, State, and local agencies and the public in commenting on statements prepared under these guidelines.

(b) Pursuant to section 204(3) of the Act the Council on Environmental Quality (hereafter "the Council") is assigned the duty and function of reviewing and appraising the programs and activities of the Federal Government, in the light of the Act's policy, for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto. Section 102(2)(B) of the Act directs all Federal agencies to identify and develop methods and procedures, in consultation with the Council, to insure that unquantified environmental values be given appropriate consideration in decisionmaking along with economic and technical considerations; section 102(2)(C) of the Act directs that copies of all environmental impact statements be filed with the Council; and section 102(2)(H) directs all Federal agencies to assist the Council in the performance of its functions. These provisions have been supplemented in sections 3 (h) and (i) of Executive Order 11514 by direction that the Council issue guidelines to Federal agencies for preparation of environmental impact statements and such other instructions to agencies and requests for reports and information as may be required to carry out the Council's responsibilities under the Act.

§ 1500.2 POLICY

(a) As early as possible and in all cases prior to agency decision concerning recommendations or favorable reports on proposals for (1) legislation significantly affecting the quality of the human environment (see §§ 1500.5(i) and 1500.12) (hereafter "legislative actions") and (2) all other major Federal actions significantly affecting the quality of the human environment (hereafter "administrative actions"), Federal agencies will, in consultation with other appropriate Federal, State and local agencies and the public assess in detail the potential environmental impact.

(b) Initial assessments of the environmental impacts of proposed action should be undertaken concurrently with initial technical and economic studies and, where required, a draft environmental impact statement prepared and circulated for comment in time to accompany the proposal through the existing agency review processes for such action. In this process, Federal agencies shall: (1) Provide for circulation of draft environmental statements to other Federal, State, and local agencies and for their availability to the public in accordance with the provisions of these guidelines; (2) consider the comments of the agencies and the public; and (3) issue final environmental impact statements responsive to the comments received. The purpose of this assessment and consultation process is to provide agencies and other decision-makers as well as members of the public with an understanding of the potential environmental effects of proposed actions, to avoid or minimize adverse effects wherever possible, and to restore or enhance environmental quality to the fullest extent practicable. In particular, agencies should use the environmental impact statement process to explore alternative actions that will avoid or minimize adverse impacts and to evaluate both the long- and short-range implications of proposed actions to man, his physical and social surroundings, and to nature. Agencies should consider the results of their environmental assessments along with their assessments of the net economic, technical and other benefits of proposed actions and use all practicable means, consistent with other essential considerations of national policy, to restore environmental quality as well as to avoid or minimize undesirable consequences for the environment.

§ 1500.3 AGENCY AND OMB PROCEDURES

(a) Pursuant to section 2(f) of Executive Order 11514, the heads of Federal agencies have been directed to proceed with measures required by section 102 (2)(C) of the Act. Previous guidelines of the Council directed each agency to establish its own formal procedures for (1) identifying those agency actions requiring environmental statements, the appropriate time prior to decision for the consultations required by section 102(2)(C) and the agency review process for which environmental statements are to be available, (2) obtaining information required in their preparation, (3) designating the officials who are to be responsible for the statements, (4) consulting with and taking account of the comments of appropriate Federal, State and local agencies and the public, including obtaining the comment of the Administrator of the Environmental Protection Agency when required under section 309 of the Clean Air Act, as amended, and (5) meeting the requirements of section 2(b) of Executive Order 11514 for providing timely public information on Federal plans and programs with environmental impact. Each agency, including both departmental and subdepartmental components having such procedures, shall review its procedures and shall revise them, in consultation with the Council, as may be necessary in order to respond to requirements imposed by these revised guidelines as well as by such previous directions. After such consultation, proposed revisions of such agency procedures shall be published in the FEDERAL REGISTER no later than October 30, 1973. A minimum 45-day period for public comment shall be provided, followed by publication of final procedures no later than forty-five (45 days) after the conclusion of the comment period. Each agency shall submit seven (7) copies of all such procedures to the Council. Any future revision of such agency procedures shall similarly be proposed and adopted only after prior consultation with the Council and, in the case of substantial revision, opportunity for public comment. All revisions shall be published in the FEDERAL REGISTER.

(b) Each Federal agency should consult, with the assistance of the Council and the Office of Management and Budget if desired, with other appropriate Federal agencies in the development and revision of the above procedures so as to achieve consistency in dealing with similar activities and to assure effective coordination among agencies in their review of proposed activities. Where applicable State and local review of such agency procedures should be conducted pursuant to procedures established by Office of Management and Budget Circular No. A–85.

(c) Existing mechanisms for obtaining the views of Federal, State, and local agencies on proposed Federal actions should be utilized to the maximum extent practicable in dealing with environmental matters. The Office of Management and Budget will issue instructions, as necessary, to take full advantage of such existing mechanisms.

§ 1500.4 FEDERAL AGENCIES INCLUDED; EFFECT OF THE ACT ON EXISTING AGENCY MANDATES

(a) Section 102(2)(C) of the Act applies to all agencies of the Federal Government. Section 102 of the Act provides that "to the fullest extent possible: (1) The policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act," and section 105 of the Act provides that "the policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies." This means that each agency shall interpret the provisions of the Act as a supplement to its existing authority and as a mandate to view traditional policies and missions in the light of the Act's national environmental objectives. In accordance with this purpose, agencies should continue to review their policies, procedures, and regulations and to revise them as necessary to ensure full compliance with the purposes and provisions of the Act. The phrase "to the fullest extent possible" in section 102 is meant to make clear that each agency of the Federal Government shall comply with that section unless existing law applicable to the agency's operations expressly prohibits or makes compliance impossible.

§ 1500.5 TYPES OF ACTIONS COVERED BY THE ACT

(a) "Actions" include but are not limited to:

(1) Recommendations or favorable reports relating to legislation including requests for appropriations. The requirement for following the section 102 (2)(C) procedure as elaborated in these guidelines applies to both (i) agency recommendations on their own proposals for legislation (see § 1500.12); and (ii) agency reports on legislation initiated elsewhere. In the latter case only the agency which has primary responsibility for the subject matter involved will prepare an environmental statement.

(2) New and continuing projects and program activities: directly undertaken by Federal agencies; or supported in whole or in part through Federal contracts, grants, subsidies, loans, or other forms of funding assistance (except where such assistance is solely in the form of general revenue sharing funds, distributed under the State and Local Fiscal Assistance Act of 1972, 31 U.S.C. 1221 et seq. with no Federal agency control over the subsequent use of such funds); or involving a Federal lease, permit, license certificate or other entitlement for use.

(3) The making, modification, or establishment of regulations, rules, procedures, and policy.

§ 1500.6 IDENTIFYING MAJOR ACTIONS SIGNIFICANTLY AFFECTING THE ENVIRONMENT

(a) The statutory clause "major Federal actions significantly affecting the quality of the human environment" is to be construed by agencies with a view to the overall, cumulative impact of the action proposed, related Federal actions and projects in the area, and further actions contemplated. Such actions may be localized in their impact, but if there is potential that the environment may be significantly affected, the statement is to be prepared. Proposed major actions, the environmental impact of which is likely to be highly controversial, should be covered in all cases. In considering what constitutes major action significantly affecting the environment, agencies should bear in mind that the effect of many Federal decisions about a project or complex of projects can be individually limited but cumulatively considerable. This can occur when one or more agencies over a period of years puts into a project individually minor but collectively major resources, when one decision involving a limited amount of money is a precedent for action in much larger cases or represents a decision in principle about a future major course of action, or when several Government agencies individually make decisions about partial aspects of a major action. In all such cases, an environmental statement should be prepared if it is reasonable to anticipate a cumulatively significant impact on the environment from Federal action. The Council, on the basis of a written assessment of the impacts involved, is available to assist agencies in determining whether specific actions require impact statements.

(b) Section 101(b) of the Act indicates the broad range of aspects of the environment to be surveyed in any assessment of significant effect. The Act also indicates that adverse significant effects include those that degrade the quality of the environment, curtail the range of beneficial uses of the environment, and serve short-term, to the disadvantage of long-term, environmental goals. Significant effects can also include actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial. Significant effects also include secondary effects, as described more fully, for example, in § 1500.8(a)(iii)(B). The significance of a proposed action may also vary with the setting, with the result that an action that would have little impact in an urban area may be significant in a rural setting or vice versa. While a precise definition of environmental "significance," valid in all contexts, is not possible, effects to be considered in assessing significance include, but are not limited to, those outlined in Appendix II of these guidelines.

(c) Each of the provisions of the Act, except section 102(2)(C), applies to all Federal agency actions. Section 102(2)(C) requires the preparation of a detailed environmental impact statement in the case of "major Federal actions significantly affecting the quality of the human environment." The identification of major actions significantly affecting the environment is the responsibility of each Federal agency, to be carried out against the background of its own particular operations. The action must be a (1) "major" action, (2) which is a "Federal action," (3) which has a "significant" effect, and (4) which involves the "quality of the human environment." The words "major" and "significantly" are intended to imply thresholds of importance and impact that must be met before a statement is required. The action causing the impact must also be one where there is sufficient Federal control and responsibility to constitute "Federal action" in contrast to cases where such Federal control and responsibility are not present as, for example, when Federal funds are distributed in the form of general revenue sharing to be used by State and local governments (see § 1500.5a(ii)). Finally, the action must be one that significantly affects the quality of the human environment either by directly affecting human beings or by indirectly affecting human beings through adverse effects on the environment. Each agency should review the typical classes of actions that it undertakes and, in consultation with the Council, should develop specific criteria and methods for identifying those actions likely to require environmental statements and those actions likely not to require environmental statements. Normally this will involve:

(i) Making an initial assessment of the environmental impacts typically associated with principal types of agency action.

(ii) Identifying on the basis of this assessment, types of actions which normally do, and types of actions which normally do not, require statements.

(iii) With respect to remaining actions that may require statements depending on the circumstances, and those actions determined under the preceding paragraph (ii) of this section as likely to require statements, identifying: (*a*) what basic information needs to be gathered; (*b*) how and when such information is to be assembled and analyzed; and (*c*) on what bases environmental assessments and decisions to prepare impact statements will be made. Agencies may either include this substantive guidance in the procedures issued pursuant to § 1500.3(a) of these guidelines, or issue such guidance as supplemental instructions to aid relevant agency personnel in implementing the impact statement process. Pursuant to § 1500.14 of these guidelines, agencies shall report to the Council by June 30, 1974, on the progress made in developing such substantive guidance.

(d)(1) Agencies should give careful attention to identifying and defining the purpose and scope of the action which would most appropriately serve as the subject of the statement. In many cases, broad program statements will be required in order to assess the environmental effects of a number of individual actions on a given geographical area (e.g., coal leases), or environmental impacts that are generic or common to a series of agency actions (e.g., maintenance or waste handling practices), or the overall impact of a large-scale program or chain of contemplated projects (e.g., major lengths of highway as opposed to small segments). Subsequent statements on major individual actions will be necessary where such actions have significant environmental impacts not adequately evaluated in the program statement.

(2) Agencies engaging in major technology research and development programs should develop procedures for periodic evaluation to determine when a program statement is required for such programs. Factors to be considered in making this determination include the magnitude of Federal investment in the program, the likelihood of widespread application of the technology, the degree of environmental impact which would occur if the technology were widely applied, and the extent to which continued investment in the new technology is likely to restrict future alternatives. Statements must be written late enough in the development process to contain meaningful information, but early enough so that this information can practically serve as an input in the decision-making process. Where it is anticipated that a statement may ultimately be required but that its preparation is still premature, the agency should prepare an evaluation briefly setting forth the reasons for its determi-

nation that a statement is not yet necessary. This evaluation should be periodically updated, particularly when significant new information becomes available concerning the potential environmental impact of the program. In any case, a statement must be prepared before research activities have reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives. Statements on technology research and development programs should include an analysis not only of alternative forms of the same technology that might reduce any adverse environmental impacts but also of alternative technologies that would serve the same function as the technology under consideration. Efforts should be made to involve other Federal agencies and interested groups with relevant expertise in the preparation of such statements because the impacts and alternatives to be considered are likely to be less well defined than in other types of statements.

(e) In accordance with the policy of the Act and Executive Order 11514 agencies have a responsibility to develop procedures to insure the fullest practicable provision of timely public information and understanding of Federal plans and programs with environmental impact in order to obtain the views of interested parties. In furtherance of this policy, agency procedures should include an appropriate early notice system for informing the public of the decision to prepare a draft environmental statement on proposed administrative actions (and for soliciting comments that may be helpful in preparing the statement) as soon as is practicable after the decision to prepare the statement is made. In this connection, agencies should: (1) maintain a list of administrative actions for which environmental statements are being prepared; (2) revise the list at regular intervals specified in the agency's procedures developed pursuant to § 1500.3(a) of these guidelines (but not less than quarterly) and transmit each such revision to the Council; and (3) make the list available for public inspection on request. The Council will periodically publish such lists in the FEDERAL REGISTER. If an agency decides that an environmental statement is not necessary for a proposed action (i) which the agency has identified pursuant to § 1500.6(c)(ii) as normally requiring preparation of a statement, (ii) which is similar to actions for which the agency has prepared a significant number of statements, (iii) which the agency has previously announced would be the subject of a statement, or (iv) for which the agency has made a negative determination in response to a request from the Council pursuant to § 1500.11(f), the agency shall prepare a publicly available record briefly setting forth the agency's decision and the reasons for that determination. Lists of such negative determinations, and any evaluations made pursuant to § 1500.6 which conclude that preparation of a statement is not yet timely, shall be prepared and made available in the same manner as provided in this subsection for lists of statements under preparation.

§ 1500.7 PREPARING DRAFT ENVIRONMENTAL STATEMENTS; PUBLIC HEARINGS

(a) Each environmental impact statement shall be prepared and circulated in draft form for comment in accordance with the provisions of these guidelines. The draft statement must fulfill and satisfy to the fullest extent possible at the time the draft is prepared the requirements established for final statements by section 102(2)(C). (Where an agency has an established practice of declining to favor an alternative until public comments on a proposed action have been received, the draft environmental statement may indicate that two or more alternatives are under consideration.) Comments received shall be carefully evaluated and considered in the decision process. A final statement with substantive comments attached shall then be issued and circulated in accordance with applicable provisions of §§ 1500.10, 1500.11, or 1500.12. It is important that draft environmental statements be prepared and circulated for comment and furnished to the Council as early as possible in the agency review process in order to permit agency decisionmakers and outside reviewers to give meaningful consideration to the environmental issues involved. In particular, agencies should keep in mind that such statements are to serve as the means of assessing the environmental impact of proposed agency actions, rather than as a justification for decisions already made. This means that draft statements on administrative actions should be prepared and circulated for comment prior to the first significant point of decision in the agency review process. For major categories of agency action, this point should be identified in the procedures issued pursuant to § 1500.3(a). For major categories of projects involving an applicant and identified pursuant to § 1500.6(c)(ii) as normally requiring the preparation of a statement, agencies should include in their procedures provisions limiting actions which an applicant is permitted to take prior to completion and review of the final statement with respect to his application.

(b) Where more than one agency (1) directly sponsors an action, or is directly involved in an action through funding, licenses, or permits, or (2) is involved in a group of actions directly related to each other because of their functional interdependence and geographical proximity, consideration should be given to preparing one statement for all the Federal actions involved (see § 1500.6(d)(1)). Agencies in such cases should consider the possibility of joint preparation of a statement by all agencies concerned, or designation of a single "lead agency" to assume supervisory responsibility for preparation of the statement. Where a lead agency prepares the statement, the other agencies involved should provide assistance with respect to their areas of jurisdiction and expertise. In either case, the statement should contain an environmental assessment of the full range of Federal actions involved, should reflect the views of all participating agencies, and should be prepared before major or irreversible actions have been taken by any of the participating agencies. Factors relevant in determining an appropriate lead agency include the time sequence in which the agencies become involved, the magnitude of their respective involvement, and their relative expertise with respect to the project's environmental effects. As necessary, the Council will assist in resolving questions of responsibility for statement preparation in the case of multi-agency actions. Federal Regional Councils, agencies and the public are encouraged to bring to the attention of the Council and other relevant agencies appropriate situations where a geographic or regionally focused statement would be desirable because of the cumulative environmental effects likely to result from multi-agency actions in the area.

(c) Where an agency relies on an applicant to submit initial environmental information, the agency should assist the applicant by outlining the types of information required. In all cases, the agency should make its own evaluation of the environmental issues and take responsibility for the scope and content of draft and final environmental statements.

(d) Agency procedures developed pursuant to § 1500.3(a) of these guidelines should indicate as explicitly as possible those types of agency decisions or actions which utilize hearings as part of the normal agency review process, either as a result of statutory requirement or agency practice. To the fullest extent possible, all such hearings shall include consideration of the environmental aspects of the proposed action. Agency procedures shall also specifically include provision for public hearings on major actions with environmental impact, whenever appropriate, and for providing the public with relevant information, including information on alternative courses of action. In deciding whether a public hearing is appropriate, an agency should consider: (1) the magnitude of the proposal in terms of economic costs, the geographic area involved, and the uniqueness or size of commitment of the resources involved; (2) the degree of interest in the proposal, as evidenced by requests from the public and from Federal, State and local authorities that a hearing be held; (3) the complexity of the issue and the likelihood that information will be presented at the hearing which will be of assistance to the agency in fulfilling its responsibilities under the Act; and (4) the extent to which public involvement already has been achieved through other means, such as earlier public hearings, meetings with citizen representatives, and/or written comments on the proposed action. Agencies should make any draft environmental statements to be issued available to the public at least fifteen (15) days prior to the time of such hearings.

§ 1500.8 CONTENT OF ENVIRONMENTAL STATEMENTS

(a) The following points are to be covered:

(1) A description of the proposed action, a statement of its purposes, and a description of the environment affected, including information, summary technical data, and maps and diagrams where relevant, adequate to permit an assessment of potential environmental impact by commenting agencies and the public. Highly technical and specialized analyses and data should be avoided in the body of the draft impact statement. Such materials should be attached as appendices or footnoted with adequate bibliographic references. The statement should also succinctly describe the environment of the area affected as it exists prior to a proposed action, including other Federal activities in the area affected by the proposed action which are related to the proposed action. The interrelationships and cumulative environmental impacts of the proposed action and other related Federal projects shall be presented in the statement. The amount of detail provided in such descriptions should be commensurate with the extent and expected impact of the action, and with the amount of information required at the particular level of decisionmaking (planning, feasibility, design, etc.). In order to ensure accurate descriptions and environmental assessments, site visits should be made where feasible. Agencies should also take care to identify, as appropriate, population and growth characteristics of the affected area and any population and growth assumptions used to justify the project or program or to determine secondary population and growth impacts resulting from the proposed action and its alternatives (see paragraph (3)(ii), of this section). In discussing these population aspects, agencies should give consideration to using the rates of growth in the region of the project contained in the projection compiled for the Water Resources Council by the Bureau of Economic Analysis of the Department of Commerce and the Economic Research Service of the Department of Agriculture (the "OBERS" projection). In any event it is essential that the sources of data used to identify, quantify or evaluate any and all environmental consequences be expressly noted.

(2) The relationship of the proposed action to land use plans, policies, and controls for the affected area. This requires a discussion of how the proposed action may conform or conflict with the objectives and specific terms of approved or proposed Federal, State, and local land use plans, policies and controls, if any, for the area affected, including those developed in response to the Clean Air Act or the Federal Water Pollution Control Act Amendments of 1972. Where a conflict or inconsistency exists, the statement should describe the extent to which the agency has reconciled its proposed action with the plan, policy or control and the reasons why the agency has decided to proceed notwithstanding the absence of full reconciliation.

(3) The probable impact of the proposed action on the environment.

(i) This requires agencies to assess the positive and negative effects of the proposed action as it affects both the national and international environment. The attention given to different environmental factors will vary according to the nature, scale, and location of proposed actions. Among factors to consider should be the potential effect of the action on such aspects of the environment as those listed in Appendix II of these guidelines. Primary attention should be given in the statement to discussing those factors most evidently impacted by the proposed action.

(ii) Secondary or indirect, as well as primary or direct, consequences for the environment should be included in the analysis. Many major Federal actions, in particular those that involve the construction or licensing of infrastructure investments (e.g., highways, airports, sewer systems, water resource projects, etc.), stimulate or induce secondary effects in the form of associated investments and changed patterns of social and economic activities. Such secondary effects, through their impacts on existing community facilities and activities, through inducing new facilities and activities, or through changes in natural conditions, may often be even more substantial than the primary effects of the original action itself. For example, the effects of the proposed action on population and growth may be among the more significant secondary effects. Such population and growth impacts should be estimated if expected to be significant (using data identified as indicated in § 1500.8(a)(1)) and an assessment made of the effect of any possible change in population patterns or growth upon the resource base, including land use, water, and public services, of the area in question.

(4) Alternatives to the proposed action, including, where relevant, those not within the existing authority of the responsible agency. (Section 102(2)(D) of the Act requires the responsible agency to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources"). A rigorous exploration and objective evaluation of the environmental impacts of all reasonable alternative actions, particularly those that might enhance environmental quality or avoid some or all of the adverse environmental effects, is essential. Sufficient analysis of such alternatives and their environmental benefits, costs and risks should accompany the proposed action through the agency review process in order not to foreclose prematurely options which might enhance environmental quality or have less detrimental effects. Examples of such alternatives include: the alternative of taking no action or of postponing action pending further study; alternatives requiring actions of a significantly different nature which would provide similar benefits with different environmental impacts (e.g., nonstructural alternatives to flood control programs, or mass transit alternatives to highway construction); alternatives related to different designs or details of the proposed action which would present different environmental impacts (e.g., cooling ponds vs. cooling towers for a power plant or alternatives that will significantly conserve energy); alternative measures to provide for compensation of fish and wildlife losses, including the acquisition of land, waters, and interests therein. In each case, the analysis should be sufficiently detailed to reveal the agency's comparative evaluation of the environmental benefits, costs and risks of the proposed action and each reasonable alternative. Where an existing impact statement already contains such an analysis, its treatment of alternatives may be incorporated provided that such treatment is current and relevant to the precise purpose of the proposed action.

(5) Any probable adverse environmental effects which cannot be avoided (such as water or air pollution, undesirable land use patterns, damage to life systems, urban congestion, threats to health or other consequences adverse to the environmental goals set out in section 101(b) of the Act). This should be a brief section summarizing in one place those effects discussed in paragraph (a)(3) of this section that are adverse and unavoidable under the proposed action. Included for purposes of contrast should be a clear statement of how other avoidable adverse effects discussed in paragraph (a)(2) of this section will be mitigated.

(6) The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity. This section should contain a brief discussion of the extent to which the proposed action involves tradeoffs between short-term environmental gains at the expense

of long-term losses, or vice versa, and a discussion of the extent to which the proposed action forecloses future options. In this context short-term and long-term do not refer to any fixed time periods, but should be viewed in terms of the environmentally significant consequences of the proposed action.

(7) Any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented. This requires the agency to identify from its survey unavoidable impacts in paragraph (a)(5) of this section the extent to which the action irreversibly curtails the range of potential uses of the environment. Agencies should avoid construing the term "resources" to mean only the labor and materials devoted to an action. "Resources" also means the natural and cultural resources committed to loss or destruction by the action.

(8) An indication of what other interests and considerations of Federal policy are thought to offset the adverse environmental effects of the proposed action identified pursuant to paragraphs (a)(3) and (5) of this section. The statement should also indicate the extent to which these stated countervailing benefits could be realized by following reasonable alternatives to the proposed action (as identified in paragraph (a)(4) of this section) that would avoid some or all of the adverse environmental effects. In this connection, agencies that prepare cost-benefit analyses of proposed actions should attach such analyses, or summaries thereof, to the environmental impact statement, and should clearly indicate the extent to which environmental costs have not been reflected in such analyses.

(b) In developing the above points agencies should make every effort to convey the required information succinctly in a form easily understood, both by members of the public and by public decisionmakers, giving attention to the substance of the information conveyed rather than to the particular form, or length, or detail of the statement. Each of the above points, for example, need not always occupy a distinct section of the statement if it is otherwise adequately covered in discussing the impact of the proposed action and its alternatives—which items should normally be the focus of the statement. Draft statements should indicate at appropriate points in the text any underlying studies, reports, and other information obtained and considered by the agency in preparing the statement including any cost-benefit analyses prepared by the agency, and reports of consulting agencies under the Fish and Wildlife Coordination Act, 16 U.S.C. 661 et seq., and the National Historic Preservation Act of 1966, 16 U.S.C. 470 et seq., where such consultation has taken place. In the case of documents not likely to be easily accessible (such as internal studies or reports), the agency should indicate how such information may be obtained. If such information is attached to the statement, care should be taken to ensure that the statement remains an essentially self-contained instrument, capable of being understood by the reader without the need for undue cross reference.

(c) Each environmental statement should be prepared in accordance with the precept in section 102(2)(A) of the Act that all agencies of the Federal Government "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and decisionmaking which may have a impact on man's environment." Agencies should attempt to have relevant disciplines represented on their own staffs; where this is not feasible they should make appropriate use of relevant Federal, State, and local agencies or the professional services of universities and outside consultants. The interdisciplinary approach should not be limited to the preparation of the environmental impact statement, but should also be used in the early planning stages of the proposed action. Early application of such an approach should help assure a systematic evaluation of reasonable alternative courses of action and their potential social, economic, and environmental consequences.

(d) Appendix I prescribes the form of the summary sheet which should accompany each draft and final environmental statement.

§ 1500.9 REVIEW OF DRAFT ENVIRONMENTAL STATEMENTS BY FEDERAL, FEDERAL–STATE, STATE, AND LOCAL AGENCIES AND BY THE PUBLIC

(a) *Federal agency review: In general.* A Federal agency considering an action requiring an environmental statement should consult with, and (on the basis of a draft environmental statement for which the agency takes responsibility) obtain the comment on the environmental impact of the action of Federal and Federal-State agencies with jurisdiction by law or special expertise with respect to any environmental impact involved. These Federal and Federal-State agencies and their relevant areas of expertise include those identified in Appendices II and III to these guidelines. It is recommended that the listed departments and agencies establish contact points, which may be regional offices, for providing comments on the environmental statements. The requirement in section 102(2)(C) to obtain comment from Federal agencies having jurisdiction or special expertise is in addition to any specific statutory obligation of any Federal agency to coordinate or consult with any other Federal or State agency. Agencies should, for example, be alert to consultation requirements of the Fish and Wildlife Coordination Act, 16 U.S.C. 661 et seq., and the National Historic Preservation Act of 1966, 16 U.S.C. 470 et seq. To the extent possible, statements or findings concerning environmental impact required by other statutes, such as section 4(f) of the Department of Transportation Act of 1966, 49 U.S.C. 1653(f), or section 106 of the National Historic Preservation Act of 1966, should be combined with compliance with the environmental impact statement requirements of section 102(2)(C) of the Act to yield a single document which meets all applicable requirements. The Advisory Council on Historic Preservation, the Department of Transportation, and the Department of Interior, in consultation with the Council, will issue any necessary supplementing instructions for furnishing information or findings not forthcoming under the environmental impact statement process.

(b) *EPA review:* Section 309 of the Clean Air Act, as amended (42 U.S.C. § 1857h–7), provides that the Administrator of the Environmental Protection Agency shall comment in writing on the environmental impact of any matter relating to his duties and responsibilities, and shall refer to the Council any matter that the Administrator determines is unsatisfactory from the standpoint of public health or welfare or environmental quality. Accordingly, wherever an agency action related to air or water quality, noise abatement and control, pesticide regulation, solid waste disposal, generally applicable environmental radiation criteria and standards, or other provision of the authority of the Administrator involved, Federal agencies are required to submit such proposed actions and their environmental impact statements, if such have been prepared, to the Administrator for review and comment in writing. In all cases where EPA determines that proposed agency action is environmentally unsatisfactory, or where EPA determines that an environmental statement is so inadequate that such a determination cannot be made, EPA shall publish its determination and notify the Council as soon as practicable. The Administrator's comments shall constitute his comments for the purposes of both section 309 of the Clean Air Act and section 102(2)(C) of the National Environmental Policy Act.

(c) *State and local review:* Office of Management and Budget Circular No. A–95 (Revised) through its system of State and areawide clearinghouses provides a means for securing the views of State and local environmental agencies, which can assist in the preparation and review of environmental impact statements. Current instructions for obtaining the views of such agencies are contained in the joint OMB–CEQ memorandum attached to these guidelines as Appendix IV. A current listing of clearinghouses is issued periodically by the Office of Management and Budget.

(d) *Public review:* The procedures established by these guidelines are designed to encourage public participation in the impact statement process at the earliest possible time. Agency procedures should make provision for facilitating the comment of public and private organizations and indviduals by announcing the availability of draft environmental statements and by making copies available to organizations and individuals that request an opportunity to comment. Agencies should devise methods for publicizing the existence of draft statements, for example, by publication of notices in local newspapers or by maintaining a list of groups, including relevant conservation commissions, known to be interested in the agency's activities and directly notifying such groups of the existence of a draft statement, or sending them a copy, as soon as it has been prepared. A copy of the draft statement should in all cases be sent to any applicant whose project is the subject of the statement. Materials to be made available to the public shall be provided without charge to the extent practicable, or at a fee which is not more than the actual cost of reproducing copies required to be sent to other Federal agencies, including the Council.

(e) *Responsibilities of commenting entities:* (1) Agencies and members of the public submitting comments on proposed actions on the basis of draft environmental statements should endeavor to make their comments as specific, substantive, and factual as possible without undue attention to matters of form in the impact statement. Although the comments need not conform to any particular format, it would assist agencies reviewing comments if the comments were organized in a manner consistent with the structure of the draft statement. Emphasis should be placed on the assessment of the environmental impacts of the proposed action, and the acceptability of those impacts on the quality of the environment, particularly as contrasted with the impacts of reasonable alternatives to the action. Commenting entities may recommend modifications to the proposed action and/or new alternatives that will enhance environmental quality and avoid or minimize adverse environmental impacts.

(2) Commenting agencies should indicate whether any of their projects not identified in the draft statement are sufficiently advanced in planning and related environmentally to the proposed action so that a discussion of the environmental interrelationships should be included in the final statement (see § 1500.8(a)(1)). The Council is available to assist agencies in making such determinations.

(3) Agencies and members of the public should indicate in their comments the nature of any monitoring of the environmental effects of the proposed project that appears particularly appropriate. Such monitoring may be necessary during the construction, startup, or operation phases of the project. Agencies with special expertise with respect to the environmental impacts involved are encouraged to assist the sponsoring agency in the establishment and operation of appropriate environmental monitoring.

(f) Agencies seeking comment shall establish time limits of not less than forty-five (45) days for reply, after which it may be presumed, unless the agency or party consulted requests a specified extension of time, that the agency or party consulted has no comment to make. Agencies seeking comment should endeavor to comply with requests for extensions of time of up to fifteen (15) days. In determining an appropriate period for comment, agencies should consider the magnitude and complexity of the statement and the extent of citizen interest in the proposed action.

§ 1500.10 PREPARATION AND CIRCULATION OF FINAL ENVIRONMENTAL STATEMENTS

(a) Agencies should make every effort to discover and discuss all major points of view on the environmental effects of the proposed action and its alternatives in the draft statement itself. However, where opposing professional views and responsible opinion have been overlooked in the draft statement and are brought to the agency's attention through the commenting process, the agency should review the environmental effects of the action in light of those views and should make a meaningful reference in the final statement to the existence of any responsible opposing view not adequately discussed in the draft statement, indicating the agency's response to the issues raised. All substantive comments received on the draft (or summaries thereof where response has been exceptionally voluminous) should be attached to the final statement, whether or not each such comment is thought to merit individual discussion by the agency in the text of the statement.

(b) Copies of final statements, with comments attached, shall be sent to all Federal, State, and local agencies and private organizations that made substantive comments on the draft statement and to individuals who requested a copy of the final statement, as well as any applicant whose project is the subject of the statement. Copies of final statements shall in all cases be sent to the Environmental Protection Agency to assist it in carrying out its responsibilities under section 309 of the Clean Air Act. Where the number of comments on a draft statement is such that distribution of the final statement to all commenting entities appears impracticable, the agency shall consult with the Council concerning alternative arrangements for distribution of the statement.

§ 1500.11 TRANSMITTAL OF STATEMENTS TO THE COUNCIL; MINIMUM PERIODS FOR REVIEW; REQUESTS BY THE COUNCIL

(a) As soon as they have been prepared, ten (10) copies of draft environmental statements, five (5) copies of all comments made thereon (to be forwarded to the Council by the entity making comment at the time comment is forwarded to the responsible agency), and ten (10) copies of the final text of environmental statements (together with the substance of all comments received by the responsible agency from Federal, State, and local agencies and from private organizations and individuals) shall be supplied to the Council. This will serve to meet the statutory requirement to make environmental statements available to the President. At the same time that copies of draft and final statements are sent to the Council, copies should also be sent to relevant commenting entities as set forth in §§ 1500.9 and 1500.10(b) of these guidelines.

(b) To the maximum extent practicable no administrative action subject to section 102(2)(C) is to be taken sooner than ninety (90) days after a draft environmental statement has been circulated for comment, furnished to the Council and, except where advance public disclosure will result in significantly increased costs of procurement to the Government, made available to the public pursuant to these guidelines; neither should such administrative action be taken sooner than thirty (30) days after the final text of an environmental statement (together with comments) has been made available to the Council, commenting agencies, and the public. In all cases, agencies should allot a sufficient review period for the final statement so as to comply with the statutory requirement that the "statement and the comments and views of appropriate Federal, State, and local agencies * * * accompany the proposal through the existing agency review processes." If the final text of an environmental statement is filed within ninety (90) days after a draft statement has been circulated for comment, furnished to the Council and made public pursuant to this section of these guidelines, the minimum thirty (30) day period and the ninety (90) day period may run concurrently to the extent that they overlap. An agency may at any time supplement or amend a draft or final environmental statement, particularly when substantial changes are made in the proposed action, or significant new information becomes available concerning its environmental aspects. In such cases the agency should consult with the Council with respect to the possible need or desirability of recirculation of the statement for the appropriate period.

(c) The Council will publish weekly in the FEDERAL REGISTER lists of environmental statements received during the preceding week that are available for public comment. The date of publication of such lists shall be the date from which the minimum periods for review and advance availability of statements shall be calculated.

(d) The Council's publication of notice of the availability of statements is in addition to the agency's responsibility, as described in § 1500.9(d) of these guidelines, to insure the fullest practicable provision of timely public information concerning the existence and availability of environmental statements. The agency responsible for the environmental statement is also responsible for making the statement, the comments received, and any underlying documents available to the public pursuant to the provisions of the Freedom of Information Act (5 U.S.C. 552), without regard to the exclusion of intra- or interagency memoranda when such memoranda transmit comments of Federal agencies on the environmental impact of the proposed action pursuant to § 1500.9 of these guidelines. Agency procedures prepared pursuant to § 1500.3 (a) of these guidelines shall implement these public information requirements and shall include arrangements for availability of environmental statements and comments at the head and appropriate regional offices of the responsible agency and at appropriate State and areawide clearinghouses unless the Governor of the State involved designates to the Council some other point for receipt of this information. Notice of such designation of an alternate point for receipt of this information will be included in the Office of Management and Budget listing of clearinghouses referred to in § 1500.9(c).

(e) Where emergency circumstances make it necessary to take an action with significant environmental impact without observing the provisions of these guidelines concerning minimum periods for agency review and advance availability of environmental statements, the Federal agency proposing to take the action should consult with the Council about alternative arrangements. Similarly where there are overriding considerations of expense to the Government or impaired program effectiveness, the responsible agency should consult with the Council concerning appropriate modifications of the minimum periods.

(f) In order to assist the Council in fulfilling its responsibilities under the Act and under Executive Order 11514, all agencies shall (as required by section 102(2)(H) of the Act and section 3(i) of Executive Order 11514) be resposive to requests by the council for reports and other information dealing with issues arising in connection with the implementaton of the Act. In particular, agencies shall be responsive to a request by the Council for the preparation and circulation of an environmental statement, unless the agency determines that such a statement is not required, in which case the agency shall prepare an environmental assessment and a publicly available record briefly setting forth the reasons for its determination. In no case, however, shall the Council's silence or failure to comment or request preparation, modification, or recirculation of an environmental statement or to take other action with respect to an environmental statement be construed as bearing in any way on the question of the legal requirement for or the adequacy of such statement under the Act.

§ 1500.12 LEGISLATIVE ACTIONS

(a) The Council and the Office of Management and Budget will cooperate in giving guidance as needed to assist agencies in identifying legislative items believed to have environmental significance. Agencies should prepare impact statements prior to submission of their legislative proposals to the Office of Management and Budget. In this regard, agencies should identify types of repetitive legislation requiring environmental impact statements (such as certain types of bills affecting transportation policy or annual construction authorizations).

(b) With respect to recommendations or reports on proposals for legislation to which section 102(2)(C) applies, the final text of the environmental statement and comments thereon should be available to the Congress and to the public for consideration in connection with the proposed legislation or report. In cases where the scheduling of congressional hearings on recommendations or reports on proposals for legislation which the Federal agency has forwarded to the Congress does not allow adequate time for the completion of a final text of an environmental statement (together with comments), a draft environmental statement may be furnished to the Congress and made available to the public pending transmittal of the comments as received and the final text.

§ 1500.13 APPLICATION OF SECTION 102(2)(C) PROCEDURE TO EXISTING PROJECTS AND PROGRAMS

Agencies have an obligation to reassess ongoing projects and programs in order to avoid or minimize adverse environmental effects. The section 102(2)(C) procedure shall be applied to further major Federal actions having a significant effect on the environment even though they arise from projects or programs initiated prior to enactment of the Act on January 1, 1970. While the status of the work and degree of completion may be considered in determining whether to proceed with the project, it is essential that the environmental impacts of proceeding are reassessed pursuant to the Act's policies and procedures and, if the project or program is continued, that further incremental major actions be shaped so as to enhance and restore environmental quality as well as to avoid or minimize adverse environmental consequences. It is also important in further action that account be taken of environmental consequences not fully evaluated at the outset of the project or program.

§ 1500.14 SUPPLEMENTARY GUIDELINES; EVALUATION OF PROCEDURES

(a) The Council after examining environmental statements and agency procedures with respect to such statements will issue such supplements to these guidelines as are necessary.

(b) Agencies will continue to assess their experience in the implementation of the section 102(2)(C) provisions of the Act and in conforming with these guidelines and report thereon to the Council by June 30, 1974. Such reports should include an identification of the problem areas and suggestions for revision or clarification of these guidelines to achieve effective coordination of views on environmental aspects (and alternatives, where appropriate) of proposed actions without imposing unproductive administrative procedures. Such reports shall also indicate what progress the agency has made in developing substantial criteria and guidance for making environmental assessments as required by § 1500.6(c) of this directive and by section 102(2)(B) of the Act.

Effective date. The revisions of these guidelines shall apply to all draft and final impact statements filed with the Council after January 28, 1974.

RUSSELL E. TRAIN,
Chairman

APPENDIX I SUMMARY TO ACCOMPANY DRAFT AND FINAL STATEMENTS

(Check one) ( ) Draft. ( ) Final Environmental Statement.

Name of responsible Federal agency (with name of operating division where appropriate). Name, address, and telephone number of individual at the agency who can be contacted for additional information about the proposed action or the statement.

1. Name of action (Check one) ( ) Administrative Action. ( ) Legislative Action.

2. Brief description of action and its purpose. Indicate what States (and counties) particularly affected, and what other proposed Federal actions in the area, if any, are discussed in the statement.

3. Summary of environmental impacts and adverse environmental effects.

4. Summary of major alternatives considered.

5. (For draft statements) List all Federal, State, and local agencies and other parties from which comments have been requested. (For final statements) List all Federal, State, and local agencies and other parties from which written comments have been received.

6. Date draft statement (and final environmental statement, if one has been issued) made available to the Council and the public.

APPENDIX II AREAS OF ENVIRONMENTAL IMPACT AND FEDERAL AGENCIES AND FEDERAL–STATE AGENCIES[1] WITH JURISDICTION BY LAW OR SPECIAL EXPERTISE TO COMMENT THEREON[2]

AIR

Air Quality

Department of Agriculture—
  Forest Service (effects on vegetation)
Atomic Energy Commission (radioactive substances)
Department of Health, Education, and Welfare
Environmental Protection Agency
Department of the Interior—
  Bureau of Mines (fossil and gaseous fuel combustion)
  Bureau of Sport Fisheries and Wildlife (effect on wildlife)
  Bureau of Outdoor Recreation (effects on recreation)
  Bureau of Land Management (public lands)
  Bureau of Indian affairs (Indian lands)
National Aeronautics and Space Administration (remote sensing, aircraft emissions)
Department of Transportation—
  Assistant Secretary for Systems Development and Technology (auto emissions)
  Coast Guard (vessel emissions)
  Federal Aviation Administration (aircraft emissions)

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[1] River Basin Commissions (Delaware, Great Lakes, Missouri, New England, Ohio, Pacific Northwest, Souris-Red-Rainy, Susquehanna, Upper Mississippi) and similar Federal-State agencies should be consulted on actions affecting the environment of their specific geographic jurisdictions.

[2] In all cases where a proposed action will have significant international environmental effects, the Department of State should be consulted, and should be sent a copy of any draft and final impact statement which covers such action.

Weather Modification

Department of Agriculture—
  Forest Service
Department of Commerce—
  National Oceanic and Atmospheric Administration
Department of Defense—
  Department of the Air Force
Department of the Interior—
  Bureau of Reclamation
Water Resources Council

WATER

Water Quality

Department of Agriculture—
  Soil Conservation Service
  Forest Service
Atomic Energy Commission (radioactive substances)
Department of the Interior—
  Bureau of Reclamation
  Bureau of Land Management (public lands)
  Bureau of Indian Affairs (Indian lands)
  Bureau of Sport Fisheries and Wildlife
  Bureau of Outdoor Recreation
  Geological Survey
  Office of Saline Water
Environmental Protection Agency
Department of Health, Education, and Welfare
Department of Defense—
  Army Corps of Engineers
  Department of the Navy (ship pollution control)
National Aeronautics and Space Administration (remote sensing)
Department of Transportation—
  Coast Guard (oil spills, ship sanitation)
Department of Commerce—
  National Oceanic and Atmospheric Administration
Water Resources Council
River Basin Commissions (as geographically appropriate)

Marine Pollution, Commercial Fishery Conservation, and Shellfish Sanitation

Department of Commerce—
  National Oceanic and Atmospheric Administration
Department of Defense—
  Army Corps of Engineers
  Office of the Oceanographer of the Navy
Department of Health, Education, and Welfare
Department of the Interior—
  Bureau of Sport Fisheries and Wildlife
  Bureau of Outdoor Recreation
  Bureau of Land Management (outer continental shelf)
  Geological Survey (outer continental shelf)
Department of Transportation—
  Coast Guard
Environmental Protection Agency
National Aeronautics and Space Administration (remote sensing)
Water Resources Council
River Basin Commissions (as geographically appropriate)

Waterway Regulation and Stream Modification

Department of Agriculture—
  Soil Conservation Service
Department of Defense—
  Army Corps of Engineers
Department of the Interior—
  Bureau of Reclamation
  Bureau of Outdoor Recreation
  Fish and Wildlife Service
  Geological Survey
Department of Transportation—
  Coast Guard
Environmental Protection Agency
National Aeronautics and Space Administration (remote sensing)
Water Resources Council
River Basin Commissions (as geographically appropriate)

FISH AND WILDLIFE

Department of Agriculture—
  Forest Service
  Soil Conservation Service
Department of Commerce—
  National Oceanic and Atmospheric Administration (marine species)
Department of the Interior—
  Bureau of Land Management
  Bureau of Outdoor Recreation
  Fish and Wildlife Service
Environmental Protection Agency

SOLID WASTE

Atomic Energy Commission (radioactive waste)
Department of Defense—
  Army Corps of Engineers
Department of Health, Education, and Welfare
Department of the Interior—
  Bureau of Mines (mineral waste, mine acid waste, municipal solid waste, recycling)
  Bureau of Land Management (public lands)
  Bureau of Indian Affairs (Indian lands)
  Geological Survey (geologic and hydrologic effects)
  Office of Saline Water (demineralization)
Department of Transportation—
  Coast Guard (ship sanitation)
Environmental Protection Agency
River Basin Commissions (as geographically appropriate)
Water Resources Council

NOISE

Department of Commerce—
  National Bureau of Standards
Department of Health, Education, and Welfare
Department of Housing and Urban Development (land use and building materials aspects)
Department of Labor—
  Occupational Safety and Health Administration

- Department of Transportation—
  - Assistant Secretary for Systems Development and Technology
  - Federal Aviation Administration, Office of Noise Abatement
- Environmental Protection Agency
- National Aeronautics and Space Administration

RADIATION

- Atomic Energy Commission
- Department of Commerce—
  - National Bureau of Standards
- Department of Health, Education, and Welfare
- Department of the Interior—
  - Bureau of Mines (uranium mines)
  - Mining Enforcement and Safety Administration (uranium mines)
- Environmental Protection Agency

HAZARDOUS SUBSTANCES

Toxic Materials

- Atomic Energy Commission (radioactive substances)
- Department of Agriculture—
  - Agricultural Research Service
  - Consumer and Marketing Service
- Department of Commerce—
  - National Oceanic and Atmospheric Administration
- Department of Defense
- Department of Health, Education, and Welfare
- Environmental Protection Agency

Food Additives and Contamination of Foodstuffs

- Department of Agriculture—
  - Consumer and Marketing Service (meat and poultry products)
- Department of Health, Education, and Welfare
- Environmental Protection Agency

Pesticides

- Department of Agriculture—
  - Agricultural Research Service (biological controls, food and fiber production)
  - Consumer and Marketing Service
  - Forest Service
- Department of Commerce—
  - National Oceanic and Atmospheric Administration
- Department of Health, Education, and Welfare
- Department of the Interior—
  - Bureau of Sport Fisheries and Wildlife (fish and wildlife effects)
  - Bureau of Land Management (public lands)
  - Bureau of Indian Affairs (Indian lands)
  - Bureau of Reclamation (irrigated lands)
  - Fish and Wildlife Service (fish and wildlife effects)
- Environmental Protection Agency

Transportation and Handling of Hazardous Materials

- Atomic Energy Commission (radioactive substances)
- Department of Commerce—
  - Maritime Administration
  - National Oceanic and Atmospheric Administration (effects on marine life and the coastal zone)

Department of Defense—
  Armed Services Explosive Safety Board
  Army Corps of Engineers (navigable waterways)
Department of Transportation—
  Federal Highway Administration, Bureau of Motor Carrier Safety
  Coast Guard
  Federal Railroad Administration
  Federal Aviation Administration
  Assistant Secretary for Systems Development and Technology
  Office of Hazardous Materials
  Office of Pipeline Safety
Environmental Protection Agency

ENERGY SUPPLY AND NATURAL RESOURCES DEVELOPMENT

Electric Energy Development, Generation, Transmission, and Use

Atomic Energy Commission (nuclear)
Department of Agriculture—
  Rural Electrification Administration (rural areas)
Department of Defense—
  Army Corps of Engineers (hydro)
Department of Health, Education, and Welfare (radiation effects)
Department of Housing and Urban Development (urban areas)
Department of the Interior—
  Bureau of Indian Affairs (Indian lands)
  Bureau of Land Management (public lands)
  Bureau of Reclamation
  Power Marketing Administration
  Geological Survey
  Bureau of Outdoor Recreation
  Fish and Wildlife Service
  National Park Service
Environmental Protection Agency
Federal Power Commission (hydro, transmission, and supply)
River Basin Commissions (as geographically appropriate)
Tennessee Valley Authority
Water Resources Council

Petroleum Development, Extraction, Refining, Transport, and Use

Department of the Interior—
  Office of Oil and Gas
  Bureau of Mines
  Geological Survey
  Bureau of Land Management (public lands and outer continental shelf)
  Bureau of Indian Affairs (Indian lands)
  Fish and Wildlife Service (effects on fish and wildlife)
  Bureau of Outdoor Recreation
  National Park Service
Department of Transportation (Transport and Pipeline Safety)
Environmental Protection Agency
Interstate Commerce Commission

Natural Gas Development, Production, Transmission, and Use

Department of Housing and Urban Development (urban areas)
Department of the Interior—
  Office of Oil and Gas
  Geological Survey

Department of the Interior—Continued
- Bureau of Mines
- Bureau of Land Management (public lands)
- Bureau of Indian Affairs (Indian lands)
- Bureau of Outdoor Recreation
- Fish and Wildlife Service
- National Park Service

Department of Transportation (transport and safety)
Environmental Protection Agency
Federal Power Commission (production, transmission, and supply)
Interstate Commerce Commission

Coal and Minerals Development, Mining, Conversion, Processing, Transport, and Use

Appalachian Regional Commission
Department of Agriculture—
- Forest Service

Department of Commerce
Department of the Interior—
- Office of Coal Research
- Mining Enforcement and Safety Administration
- Bureau of Mines
- Geological Survey
- Bureau of Indian Affairs (Indian lands)
- Bureau of Land Management (public lands)
- Bureau of Outdoor Recreation
- Fish and Wildlife Service
- National Park Service

Department of Labor—
- Occupational Safety and Health Administration

Department of Transportation
Environmental Protection Agency
Interstate Commerce Commission
Tennessee Valley Authority

Renewable Resource Development, Production, Management, Harvest, Transport, and Use

Department of Agriculture—
- Forest Service
- Soil Conservation Service

Department of Commerce
Department of Housing and Urban Development (building materials)
Department of the Interior—
- Geological Survey
- Bureau of Land Management (public lands)
- Bureau of Indian Affairs (Indian lands)
- Bureau of Outdoor Recreation
- Fish and Wildlife Service
- National Park Service

Department of Transportation
Environmental Protection Agency
Interstate Commerce Commission (freight rates)

Energy and Natural Resources Conservation

Department of Agriculture—
- Forest Service
- Soil Conservation Service

Department of Commerce—
  National Bureau of Standards (energy efficiency)
Department of Housing and Urban Development—
  Federal Housing Administration (housing standards)
Department of the Interior—
  Office of Energy Conservation
  Bureau of Mines
  Bureau of Reclamation
  Geological Survey
  Power Marketing Administration
Department of Transportation
Environmental Protection Agency
Federal Power Commission
General Services Administration (design and operation of buildings)
Tennessee Valley Authority

LAND USE AND MANAGEMENT

Land Use Changes, Planning and Regulation of Land Development

Department of Agriculture—
  Forest Service (forest lands)
  Agricultural Research Service (agricultural lands)
Department of Housing and Urban Development
Department of the Interior—
  Office of Land Use and Water Planning
  Bureau of Land Management (public lands)
  Bureau of Indian Affairs (Indian lands)
  Bureau of Sport Fisheries and Wildlife (wildlife refuges)
  Bureau of Outdoor Recreation (recreation lands)
  Fish and Wildlife Service
  National Park Service (NPS units)
Department of Transportation
Environmental Protection Agency (pollution effects)
National Aeronautics and Space Administration (remote sensing)
River Basin Commissions (as geographically appropriate)

Public Land Management

Department of Agriculture—
  Forest Service (forests)
Department of Defense
Department of the Interior—
  Bureau of Land Management
  Bureau of Indian Affairs (Indian lands)
  Bureau of Outdoor Recreation (recreation lands)
  Fish and Wildlife Service (wildlife refuges)
  National Park Service (NPS units)
Federal Power Commission (project lands)
General Services Administration
National Aeronautics and Space Administration (remote sensing)
Tennessee Valley Authority (project lands)

Protection of Environmentally Critical Areas—Floodplains, Wetlands, Beaches and Dunes, Unstable Soils, Steep Slopes, Aquifer Recharge Areas, etc.

Department of Agriculture—
  Agricultural Stabilization and Conservation Service
  Soil Conservation Service
  Forest Service

Department of Commerce—
  National Oceanic and Atmospheric Administration (coastal areas)
Department of Defense—
  Army Corps of Engineers
Department of Housing and Urban Development (urban and floodplain areas)
Department of the Interior—
  Office of Land Use and Water Planning
  Bureau of Outdoor Recreation
  Bureau of Reclamation
  Bureau of Land Management
  Fish and Wildlife Service
  Geological Survey
Environmental Protection Agency (pollution effects)
National Aeronautics and Space Administration (remote sensing)
River Basins Commissions (as geographically appropriate)
Water Resources Council

Land Use in Coastal Areas

Department of Agriculture—
  Forest Service
  Soil Conservation Service (soil stability, hydrology)
Department of Commerce—
  National Oceanic and Atmospheric Administration (impact on marine life and coastal zone management)
Department of Defense—
  Army Corps of Engineers (beaches, dredge and fill permits, Refuse Act permits)
Department of Housing and Urban Development (urban areas)
Department of the Interior—
  Office of Land Use and Water Planning
  Fish and Wildlife Service
  National Park Service
  Geological Survey
  Bureau of Outdoor Recreation
  Bureau of Land Management (public lands)
Department of Transportation—
  Coast Guard (bridges, navigation)
Environmental Protection Agency (pollution effects)
National Aeronautics and Space Administration (remote sensing)

Redevelopment and Construction in Built-Up Areas

Department of Commerce—
  Economic Development Administration (designated areas)
Department of Housing and Urban Development
Department of the Interior—
  Office of Land Use and Water Planning
Department of Transportation
Environmental Protection Agency
General Services Administration
Office of Economic Opportunity

Density and Congestion Mitigation

Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior—
  Office of Land Use and Water Planning
  Bureau of Outdoor Recreation
Department of Transportation
Environmental Protection Agency

Neighborhood Character and Continuity

Department of Health, Education, and Welfare
Department of Housing and Urban Development
National Endowment for the Arts
Office of Economic Opportunity

Impacts on Low-Income Populations

Department of Commerce—
  Economic Development Administration (designated areas)
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Office of Economic Opportunity

Historic, Architectural, and Archeological Preservation

Advisory Council on Historic Preservation
Department of Housing and Urban Development
Department of the Interior—
  National Park Service
  Bureau of Land Management (public lands)
  Bureau of Indian Affairs (Indian lands)
General Services Administration
National Endowment for the Arts

Soil and Plant Conservation and Hydrology

Department of Agriculture—
  Soil Conservation Service
  Agricultural Service
  Forest Service
Department of Commerce—
  National Oceanic and Atmospheric Administration
Department of Defense—
  Army Corps of Engineers (dredging, aquatic plants)
Department of Health, Education, and Welfare
Department of the Interior—
  Bureau of Land Management
  Fish and Wildlife Service
  Geological Survey
  Bureau of Reclamation
Environmental Protection Agency
National Aeronautics and Space Administration (remote sensing)
River Basin Commissions (as geographically appropriate)
Water Resources Council

Outdoor Recreation

Department of Agriculture—
  Forest Service
  Soil Conservation Service
Department of Defense—
  Army Corps of Engineers
Department of Housing and Urban Development (urban areas)
Department of the Interior—
  Bureau of Land Management
  National Park Service
  Bureau of Outdoor Recreation
  Bureau of Indian Affairs
  Fish and Wildlife Service
Environmental Protection Agency

National Aeronautics and Space Administration (remote sensing)
River Basin Commissions (as geographically appropriate)
Water Resources Council

APPENDIX III OFFICES WITHIN FEDERAL AGENCIES AND FEDERAL–STATE AGENCIES FOR INFORMATION REGARDING THE AGENCIES' NEPA ACTIVITIES AND FOR RECEIVING OTHER AGENCIES' IMPACT STATEMENTS FOR WHICH COMMENTS ARE REQUESTED

ADVISORY COUNCIL ON HISTORIC PRESERVATION

Office of Review and Compliance, Advisory Council on Historic Preservation, 1522 K Street, N.W., Suite 430, Washington, D.C. 20005 (202) 254–3380

DEPARTMENT OF AGRICULTURE [1]

Office of the Secretary, Attn: Coordinator Environmental Quality Activities, U.S. Department of Agriculture, Washington, D.C. 20250 (202) 447–3965

APPALACHIAN REGIONAL COMMISSION

Office of the Alternate Federal Co-Chairman, Appalachian Regional Commission, 1666 Connecticut Avenue, N.W., Washington, D.C. 20235 (202) 967–4103

DEPARTMENT OF THE ARMY (CORPS OF ENGINEERS)

Executive Director of Civil Works, Office of the Chief of Engineers, U.S. Army Corps of Engineers, Washington, D.C. 20314 (202) 693–7093

DEPARTMENT OF COMMERCE

Office of the Deputy Assistant Secretary for Environmental Affairs, U.S. Department of Commerce, Washington, D.C. 20230 (202) 967–4335

DEPARTMENT OF DEFENSE

Office of the Assistant to the Secretary of Defense for Environmental Quality, U.S. Department of Defense, Room 3D171, The Pentagon, Washington, D.C. 20301 (202) 695–3010

DELAWARE RIVER BASIN COMMISSION

Environmental Unit, Delaware River Basin Commission, Post Office Box 360, Trenton, N.J. 08603 (609) 883–9500

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[1] Requests for comments or information from individual units of the Department of Agriculture, e.g., Soil Conservation Service, Forest Service, etc. should be sent to the Office of the Secretary, Department of Agriculture, at the address given above.

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Office of the Assistant Administrator for Environment and Safety, Energy Research and Development Administration, Washington, D.C. 20545 (202) 937-3208

ENVIRONMENTAL PROTECTION AGENCY[1]

Director, Office of Federal Activities, Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460 (202) 755-0777

FEDERAL POWER COMMISSION

Office of Energy Systems, Federal Power Commission, Room 4306, 825 North Capitol Street, N.E., Washington, D.C. 20426 (202) 386-3335

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[1] Contact the Office of Federal Activities for environmental statements concerning legislation, regulations, national program proposals or other major policy issues.

For all other EPA consultation, contact the Regional Administrator in whose area the proposed action (e.g., highway or water resource construction projects) will take place. The Regional Administrators will coordinate the EPA review. Addresses of the Regional Administrators and the areas covered by their regions are as follows:

Regional Administrator I, U.S. Environmental Protection Agency Room 2303, John F. Kennedy Federal Bldg. Boston, Mass. 02203 (617) 223-4635	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
Regional Administrator II, U.S. Environmental Protection Agency Room 908, 26 Federal Plaza New York, N.Y. 10007 (212) 264-8556	New Jersey, New York, Puerto Rico, Virgin Islands
Regional Administrator III, U.S. Environmental Protection Agency Curtis Bldg., 6th & Walnut Streets Philadelphia, Pa. 19106 (215) 597-8332	Delaware, Maryland, Pennsylvania, Virginia, West Virginia, District of Columbia
Regional Administrator IV, U.S. Environmental Protection Agency 1421 Peachtree Street, N.E. Atlanta, Ga. 30309 (404) 526-5458	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee
Regional Administrator V, U.S. Environmental Protection Agency 230 South Dearborn Street Chicago, Ill. 60604 (312) 353-5758	Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

(Continued)

GENERAL SERVICES ADMINISTRATION

Office of Environmental Affairs, Office of the Deputy Administrator for Special Projects, General Services Administration, Washington, D.C. 20405 (202) 343-4161

GREAT LAKES BASIN COMMISSION

Office of the Chairman, Great Lakes Basin Commission, 3475 Plymouth Road, P.O. Box 999, Ann Arbor, Michigan 48106 (313) 769-7431

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE [1]

Office of Environmental Affairs, Office of the Assistant Secretary for Administration and Management, Department of Health, Education, and Welfare, 330 Independence Avenue, S.W., Washington, D.C. 20201 (202) 245-7243

(Continued)

Regional Administrator VI, U.S. Environmental Protection Agency 1600 Patterson Street Suite 1100 Dallas, Tex. 75201 (214) 749-1237	Arkansas, Louisiana, New Mexico, Texas, Oklahoma
Regional Administrator VII, U.S. Environmental Protection Agency 1735 Baltimore Avenue Kansas City, Mo. 64108 (816) 374-2921	Iowa, Kansas, Missouri, Nebraska
Regional Administrator VIII, U.S. Environmental Protection Agency Suite 900, Lincoln Tower 1860 Lincoln Street Denver, Colo. 80203 (303) 837-4831	Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming
Regional Administrator IX, U.S. Environmental Protection Agency 100 California Street San Francisco, Calif. 94111 (415) 556-0970	Arizona, California, Hawaii, Nevada, American Samoa, Guam, Trust Territories of Pacific Islands, Wake Island
Regional Administrator X, U.S. Environmental Protection Agency 1200 Sixth Avenue Seattle, Wash. 98101 (206) 442-1595	Alaska, Idaho, Oregon, Washington

[1] Contact the Office of Environmental Affairs for information on HEW's environmental statements concerning legislation, regulations, national program proposals or other major policy issues, and for all requests for HEW comments on impact statements of other agencies.

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DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT [*]

Director, Office of Environmental Quality, Department of Housing and Urban Development, Room 7258, Washington, D.C. 20410 (202) 755–6309

(Continued)

For information with respect to HEW actions occurring within the jurisdiction of the Departments' Regional Directors, contact the appropriate Regional Environmental Officer:

Region I:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, John F. Kennedy Center, Room E–311, Boston, Mass. 02203 (617) 223–5485

Region II:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 26 Federal Plaza, Room 3309, New York, N.Y. 10007 (212) 264–4483

Region III:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, P.O. Box 13716, Philadelphia, Pa. 19101 (215) 597–6476

Region IV:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 50 Seventh Street, N.E., Room 447, Atlanta, Ga. 30323 (404) 526–5048

Region V:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 300 South Wacker Drive, 35th floor, Chicago, Ill. 60606 (312) 353–1670

Region VI:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 1114 Commerce Street, Room 925, Dallas, Tex. 75202 (214) 749–7741

Region VII:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 601 East 12th Street, Kansas City, Mo. 64106 (816) 374–5912

Region VIII:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 1916 Stout Street, 10th floor, Denver, Colo. 80202 (303) 837–2875

Region IX:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 50 Fulton Street, Room 410, San Francisco, Calif. 94102 (415) 556–3687

Region X:
Regional Environmental Officer, U.S. Department of Health, Education, and Welfare, 1321 Second Street, Mail Stop 610, Seattle, Wash. 98101 (206) 442–7790

[*] Contact the Director with regard to environmental impacts of legislation, policy statements, program regulations and procedures, and precedent-making project decisions. For all other consultation, contact the HUD Regional Administrator in whose jurisdiction the project lies, as follows:

Regional Administrator I, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, John F. Kennedy Federal Building, Room 405, Boston, Mass. 02203 (617) 223–4347

(Continued)

DEPARTMENT OF THE INTERIOR[*]

Director, Office of Environmental Project Review, Department of the Interior, Interior Building, Washington, D.C. 20240 (202) 343-3891

INTERSTATE COMMERCE COMMISSION

Office of Proceedings, Environmental Section, Interstate Commerce Commission, Washington, D.C. 20423 (202) 343-7966

DEPARTMENT OF LABOR

Office of Manpower for Policy Evaluation and Research, Division of Manpower Policy and Planning, Department of Labor, 601 D Street, N.W., Washington, D.C. 20210 (202) 376-6274

MISSOURI RIVER BASIN COMMISSION

Office of the Chairman, Missouri River Basin Commission, 10050 Regency Circle, Omaha, Nebr. 68114 (402) 397-5714

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Office of Policy Analysis, National Aeronautics and Space Administration, 400 Maryland Avenue, Washington, D.C. 20546 (202) 755-8433

(Continued)

Regional Administrator II, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, 26 Federal Plaza, New York, N.Y. 10007 (212) 264-4197

Regional Administrator III, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, Curtis Building, Sixth and Walnut Streets, Philadelphia, Pa. 19106 (215) 597-2520

Regional Administrator IV, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, Pershing Point Plaza, 1371 Peachtree Street, N.E., Atlanta, Ga. 30309 (404) 526-3521

Regional Administrator V, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, 300 South Wacker Drive, Chicago, Ill. 60606 (312) 353-1680

Regional Administrator VI, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, U.S. Courthouse, 1100 Commerce Street, Dallas, Tex. 75202 (214) 749-7466

Regional Administrator VII, Environmental Clearance Officer, U.S. Department of Housing nad Urban Development, 911 Walnut Street, Kansas City, Mo. 64106 (816) 374-3191

Regional Administrator VIII, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, 1961 Stout Street, Denver, Colo. 80202 (303) 837-3811

Regional Administrator IX, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, 450 Golden Gate Avenue, P.O. Box 36003, San Francisco, Calif. 94102 (415) 556-5720

Regional Administrator X, Environmental Clearance Officer, U.S. Department of Housing and Urban Development, 1321 Second Avenue, Seattle, Wash. 98101 (206) 442-7790

[*] Requests for comments or information from individual units of the Department of the Interior should be sent to the Office of Environmental Project Review at the address given above.

NATIONAL CAPITAL PLANNING COMMISSION

Office of Environmental Affairs, National Capital Planning Commission, Washington, D.C. 20576 (202) 382-7200

NATIONAL ENDOWMENT FOR THE ARTS

Office of the Director, Architecture and Environmental Arts Program, National Endowment for the Arts, Washington, D.C. 20506 (202) 634-4276

NEW ENGLAND RIVER BASIN COMMISSION

Office of the Chairman, New England River Basin Commission, 55 Court Street, Boston, Mass. 02108 (617) 223-6244

NUCLEAR REGULATORY COMMISSION

For Nuclear Power Plants: Office of the Assistant Director for Environmental Projects, Division of Nuclear Reactor Licensing, Nuclear Regulatory Commission, Washington, D.C. 20555 (202) 443-6965

For Fuel-cycle Projects: Fuel-cycle Environmental Projects Branch, Division of Materials and Fuel-cycle Facility Licensing, Nuclear Regulatory Commission, Washington, D.C. 20555 (202) 492-7631

OHIO RIVER BASIN COMMISSION

Office of the Chairman, Ohio River Basin Commission, 36 East 4th Street, Suite 208, Cincinnati, Ohio 45202 (513) 684-3831

PACIFIC NORTHWEST RIVER BASIN COMMISSION

Office of the Chairman, Pacific Northwest River Basin Commission, Post Office Box 908, Vancouver, Wash. 98660 (206) 694-2581

SOURIS-RED-RAINY RIVER BASINS COMMISSION

Office of the Chairman, Souris-Red-Rainy River Basins Commission, Suite 6, Professional Building, Holiday Mall, Moorhead, Minnesota 56560 (701) 237-5227

DEPARTMENT OF STATE

Office of Environmental Affairs, Room 7822, Department of State, Washington, D.C. 20520 (202) 632-9278

SUSQUEHANNA RIVER BASIN COMMISSION

Office of the Executive Director, Susquehanna River Basin Commission, 5012 Lenker Street, Mechanicsburg, Pa. 17055 (717) 737-0501

TENNESSEE VALLEY AUTHORITY

Office of the Chief of Environmental Assessment and Compliance Staff, Tennessee Valley Authority, 267—401 Building, Chattanooga, Tenn. 37401 (615) 755-3175

DEPARTMENT OF TRANSPORTATION [*]

Director, Office of Environmental Affairs, Office of the Assistant Secretary for Environment, Safety, and Consumer Affairs, Department of Transportation, Washington, D.C. 20590 (202) 426-4357

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[*] Contact the Office of Environmental Quality, Department of Transportation, for information on DOT's environmental statements concerning legislation, regulations, national program proposals, or other major policy issues.

For information regarding the Department of Transportation's other environmental statements, contact the national office for the appropriate administration:

U.S. Coast Guard

Office of Ports and Waterways Planning, U.S. Coast Guard, 400 Seventh Street, S.W., Washington, D.C. 20590 (202) 426-8722

Federal Aviation Administration

Office of Environmental Quality, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20591 (202) 426-8722

Federal Highway Administration

Office of Environmental Policy, Environmental Programs Division, Federal Highway Administration, 400 Seventh Street, S.W., Washington, D.C. 20590 (202) 426-0106

Federal Railroad Administration

Office of the Chief Counsel, Federal Railroad Administration, 400 Seventh Street, S.W., Washington, D.C. 20590 (202) 426-0767

Urban Mass Transportation Administration

Capitol Assistance, Urban Mass Transportation Administration, 400 Seventh Street, S.W., Washington, D.C. 20590 (202) 426-1985

For other administrations not listed above, contact the Office of Environmental Quality, Department of Transportation, at the address given above.

For comments on other agencies' environmental statements, contact the appropriate administration's regional office. If more than one administration within the Department of Transportation is to be requested to comment, contact the Secretarial Representative in the appropriate Regional Office for coordination of the Department's comments:

Secretarial Representative

Region I Secretarial Representative, U.S. Department of Transportation, Transportation Systems Center, 55 Broadway, Cambridge, Mass. 02142 (617) 494-2709

Region II Secretarial Representative, U.S. Department of Transportation, 26 Federal Plaza, Room 1811, New York, N.Y. 10007 (212) 264-2672

Region III Secretarial Representative, U.S. Department of Transportation, 434 Walnut Street, 10th floor, Philadelphia, Pa. 19106 (215) 597-9430

Region IV Secretarial Representative, U.S. Department of Transportation, Suite 515, 1720 Peachtree Rd., N.W., Atlanta, Ga. 30309 (404) 526-3738

Region V Secretarial Representative, U.S. Department of Transportation, 17th Floor, 300 S. Wacker Drive, Chicago, Ill. 60606 (312) 353-4000

Region VI Secretarial Representative, U.S. Department of Transportation, 9-C-18 Federal Center, 1100 Commerce Street, Dallas, Tex. 75202 (214) 749-1851

Region VII Secretarial Representative, U.S. Department of Transportation, 601 East 12th Street, Room 634, Kansas City, Mo. 64106 (816) 374-5801

Region VIII Secretarial Representative, U.S. Department of Transportation, Prudential Plaza, Suite 1822, 1050 17th Street, Denver, Colo. 80202 (303) 837-3242

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Region IX Secretarial Representative, U.S. Department of Transportation, 450 Golden Gate Avenue, Box 36133, San Francisco, Calif. 94102 (415) 556-5961

Region X Secretarial Representative, U.S. Department of Transportation, 3112 Federal Building, 915 Second Street, Seattle, Wash. 98174 (206) 442-0590

Federal Aviation Administration

New England Region, Office of the Regional Director, Federal Aviation Administration, 12 Northeast Executive Park, Burlington, Mass. 01803 (617) 467-7244

Eastern Region, Office of the Regional Director, Federal Aviation Administration, Federal Building, JFK International Airport, Jamaica, N.Y. 11430 (212) 995-3333

Southern Region, Office of the Regional Director, Federal Aviation Administration, P.O. Box 20636, Atlanta, Ga. 30320 (404) 526-7222

Great Lakes Region, Office of the Regional Director, Federal Aviation Administration, 2300 East Devon, Des Plaines, Ill. 60018 (312) 694-4500

Southwest Region, Office of the Regional Director, Federal Aviation Administration, P.O. Box 1689, Fort Worth, Tex. 76101 (817) 624-4911

Central Region, Office of the Regional Director, Federal Aviation Administration, 601 East 12th Street, Kansas City, Mo. 64106 (816) 374-5626

Rocky Mountain Region, Office of the Regional Director, Federal Aviation Administration, Park Hill Station, P.O. Box 7213, Denver, Colo. 80207 (303) 837-3646

Western Region, Office of the Regional Director, Federal Aviation Administration, P.O. Box 92007, Worldway Postal Center, Los Angeles, Calif. 90009 (213) 536-6435

Northwest Region, Office of the Regional Director, Federal Aviation Administration, FAA Building, 9010 East Marginal Way South, King County International Airport, Seattle, Wash. 98108 (206) 767-2780

Federal Highway Administration

Region 1:
Regional Administrator, Federal Highway Administration, 4 Normanskill Boulevard, Delmar, N.Y. 12054 (518) 472-6476

Region 3:
Regional Administrator, Federal Highway Administration, George H. Fallon Federal Office Building, Room 1633, 31 Hopkins Plaza, Baltimore, Md. 21201 (301) 962-2361

Region 4:
Regional Administrator, Federal Highway Administration, 1720 Peachtree Road, N.W., Suite 200, Atlanta, Ga. 30309 (404) 526-5078

Region 5:
Regional Administrator, Federal Highway Administration, 18209 Dixie Highway, Homewood, Ill. 60430 (312) 799-6300

Region 6:
Regional Administrator, Federal Highway Administration, 819 Taylor Street, Fort Worth, Tex. 76102 (817) 334-3232

Region 7:
Regional Administrator, Federal Highway Administration, P.O. Box 7186, Country Club Station, Kansas City, Mo. 64113 (816) 926-7563

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UPPER MISSISSIPPI RIVER BASIN COMMISSION

Office of the Chairman, Upper Mississippi River Basin Commission, Federal Office Building, Room 510, Fort Snelling, Twin Cities, Minn. 55111 (612) 725-4690

WATER RESOURCES COUNCIL

Office of the Assistant Director, Planning Division, Water Resources Council, 2120 L Street, N.W., Suite 800, Washington, D.C. 20037 (202) 254-6442

(Continued)

Region 8:
Regional Administrator, Federal Highway Administration, Building 40, Room 242, Denver Federal Center, Denver, Colo. 80225 (303) 236-4051

Region 9:
Regional Administrator, Federal Highway Administration, 450 Golden Gate Avenue, Box 36112, San Francisco, Calif. 94102 (415) 556-6415

Region 10:
Regional Administrator, Federal Highway Administration, Mohawk Building, Room 412, 222 Southwest Morrison Street, Portland, Oreg. 97204 (503) 221-2065

Urban Mass Transportation Administration

Region I, Office of the UMTA Representative, Urban Mass Transportation Administration, Transportation Systems, Kendall Square, Cambridge, Mass. 02142 (617) 494-2005

Region II, Office of the UMTA Representative, Urban Mass Transportation Administration, 26 Federal Plaza, Suite 507, New York, N.Y. 10007 (212) 264-8162

Region III, Office of the UMTA Representative, Urban Mass Transportation Administration, 434 Walnut Street, 10th floor, Philadelphia, Pa. 19106 (215) 597-8098

Region IV, Office of UMTA Representative, Urban Mass Transportation Administration, 1720 Peachtree Road, Northwest, Suite 501, Atlanta, Ga. 30309 (404) 526-3948

Region V, Office of the UMTA Representative, Urban Mass Transportation Administration, 300 South Wacker Drive, Suite 700, Chicago, Ill. 60606 (312) 353-6005

Region VI, Office of the UMTA Representative, Urban Mass Transportation Administration, Federal Center, Suite 9A32, 819 Taylor Street, Fort Worth, Tex. 76102 (817) 334-3896

Region VII, Office of the UMTA Representative, Urban Mass Transportation Administration, Suite 633, 601 East 12th Street, Kansas City, Mo. 64106 (816) 374-5845

Region VIII, Office of the UMTA Representative, Urban Mass Transportation Administration, Prudential Plaza, Suite 1822, 1050 17th Street, Denver, Colo. 80202 (303) 837-3242

Region IX, Office of the UMTA Representative, Urban Mass Transportation Administration, 450 Golden Gate Avenue, Box 36125, San Francisco, Calif. 94102 (415) 556-2884

Region X, Office of the UMTA Representative, Urban Mass Transportation Administration, Federal Building, Suite 3106, 915 Second Avenue, Seattle, Wash. 98174 (206) 442-4210

APPENDIX IV STATE AND LOCAL AGENCY REVIEW OF IMPACT STATEMENTS

1. OMB Circular No. A–95 through its system of clearinghouses provides a means for securing the views of State and local environmental agencies, which can assist in the preparation of impact statements. Under A–95, review of the proposed project in the case of federally assisted projects (Part I of A–95) generally takes place prior to the preparation of the impact statement. Therefore, comments on the environmental effects of the proposed project that are secured during this stage of the A–95 process represent inputs to the environmental impact statement.

2. In the case of direct Federal development (Part II of A–95), Federal agencies are required to consult with clearinghouses at the earliest practicable time in the planning of the project or activity. Where such consultation occurs prior to completion of the draft impact statement, comments relating to the environmental effects of the proposed action would also represent inputs to the environmental impact statement.

3. In either case, whatever comments are made on environmental effects of proposed Federal or federally assisted projects by clearinghouses, or by State and local environmental agencies through clearinghouses, in the course of the A–95 review should be attached to the draft impact statement when it is circulated for review. Copies of the statement should be sent to the agencies making such comments. Whether those agencies then elect to comment again on the basis of the draft impact statement is a matter to be left to the discretion of the commenting agency depending on its resources, the significance of the project, and the extent to which its earlier comments were considered in preparing the draft statement.

4. The clearinghouses may also be used, by mutual agreement, for securing reviews of the draft environmental impact statement. However, the Federal agency may wish to deal directly with appropriate State or local agencies in the review of impact statements because the clearinghouses may be unwilling or unable to handle this phase of the process. In some cases, the Governor may have designated a specific agency, other than the clearinghouse, for securing reviews of impact statements. In any case, the clearinghouses should be sent copies of the impact statement.

5. To aid clearinghouses in coordinating State and local comments, draft statements should include copies of State and local agency comments made earlier under the A–95 process and should indicate on the summary sheet those other agencies from which comments have been requested, as specified in Appendix I of the CEQ Guidelines.

APPENDIX F

FEDERAL ENVIRONMENTAL PROGRAM BUDGETS*

INTRODUCTION

$6.5 billion in outlays on environmental programs has been initiated by 19 agencies and departments within the Federal Government in 1975 and $6.9 billion is expected to be spent in 1976. Although these programs span a wide spectrum of activities ranging from basic ecological research to abatement of pollution from Federal facilities, all Federal expenditures on the environment can be classified in one of three broad categories: Pollution control and abatement; understanding, describing, and predicting the environment; and environmental protection and enhancement activities. The distribution of outlays by the Federal Government on these three categories of activity are displayed in chart Q–1, and summarized by type of spending for 1976 in the following schedule:

1976 Budget Authority and Outlays—Federal Environmental Programs

(In millions of dollars)

	Authority	Outlays
Protection and enhancement	1,036.4	1,069.5
Understanding, describing, and predicting	1,379.1	1,309.3
Pollution control and abatement	1.933.2	2,102.3
Construction grants	(1)	2,439.6
Total	4,348.7	6,920.7

[1] Contract authority for the Environmental Protection Agency's 1976 sewage facility grant program is included as 1975 budget authority since it is allocated and available for obligation in 1975.

It should also be noted that Federal expenditures, unlike those of the private sector, can occur either as an outlay by a Federal agency for services rendered to itself (in-house activities) or as a transfer (grant) to States or local governments which, as the ultimate distributors of those funds are also rendered the services.

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*Office of Management and Budget, *Special Analyses: Budget of the United States Government, Fiscal Year 1976* (Washington, D.C.: Government Printing Office, 1975), pp. 268–81.

The distinctions between direct Federal expenditures and those transferred to State and local governments are summarized by type of spending for 1976 in the following table:

1976 Federal Outlays for Environmental Programs

(In millions of dollars)

	Outlays	
	Direct	Transfer
Enchancement	659.5	410.0
Understanding, describing, and predicting	1,309.3	(1)
Pollution abatement (excluding construction grants)	1,789.9	312.4
Construction grants	(1)	2,439.6
Total	3,758.7	3,162.0

[1] Not applicable.

POLLUTION CONTROL AND ABATEMENT ACTIVITIES

The largest portion (66.0%) of Federal outlays expended on the environment occur for purposes of cleaning up the environment and preventing further deterioration. In 1976, outlays are estimated to be $4,541.9 million.

Pollution Control and Abatement Expenditures (Including Construction Grants)

(In millions of dollars)

	1974 actual	1975 estimate	1976 estimate
Budget authority	6,894.8	5,245.0	[1] 1,933.2
Outlays	2,974.2	4,212.5	4,541.9

[1] See footnote at bottom of Table Q-1.

Within the pollution abatement and control category there are three primary areas of direct Federal activity—direct action to reduce pollution from Federal facilities, establishing and enforcing standards, and actions designed to research and develop technology and procedures to abate pollution as well as to identify the nature and sources of those pollutants.

Two additional types of activity occur under the category pollution abatement and control. They are the allocation of substantial funds to State and local governments under financial assistance programs and a small amount of funding for manpower development. Table Q-1 reflects these five major activities.

ACTIVITIES INVOLVED

Financial Aid

A substantial portion of 1976 Federal outlays in the financial aid category will be directed toward the construction of sewage treatment facilities. Of

Table Q–1

Pollution Control and Abatement Activities by Function

(In millions of dollars)

Type of activity	Budget authority			Outlays		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Financial aid to State, interstate, and local governments	5,644.8	3,718.6	[1] 226.1	1,867.2	2,698.7	2,752.0
Research and development	506.2	713.4	710.4	414.5	581.3	683.6
Standard setting and enforcement	312.5	371.5	433.9	303.7	368.4	416.5
Reduce pollution from Federal facilities	337.2	343.6	415.4	300.6	469.3	570.7
Manpower development	11.5	10.7	17.4	9.5	10.3	13.4
Other	82.6	87.2	130.0	78.7	84.5	105.7
Total	6,894.8	5,245.0	1,933.2	2,974.2	4,212.5	4,541.9

[1] Contract authority for the Environmental Protection Agency's sewage facility grant program is included as 1975 budget authority since it is allocated and available for obligation in 1975. It therefore appears in columns for budget authority for that year instead of the 1976 column.

the $2,752.0 million in outlays, $2,439.6 million will be expended on the construction of these plants. These grant funds cover 75% of the eligible costs of these projects. Also included in this activity are funds made available to State, regional, and local agencies to help support their air and water pollution control programs. Outlays of $312.4 million will be generated in 1976 to provide financial assistance for such objectives as implementing the national primary and secondary ambient air quality monitoring systems, emission inventories, plans for effective enforcement of standards, transportation control plan development, and air pollution emergency plans.

Research, Development, and Demonstration

Table Q–1 indicates that outlays on research and development will increase from $581.3 million in 1975 to $683.6 million in 1976.

The research and development outlay figures include both primary and secondary activities. Primary refers to a research activity which has pollution control and abatement as its sole purpose; whereas secondary refers to a research activity which contributes to pollution abatement but which has some other primary purpose; for example, research on fish or animal migrations. Research and development activities begin with efforts directed toward identifying pollutants, determining their sources, and establishing their effects on the environment in general. Research on pollution control technology provides the next step in the research process. Once the sources and effects of dangerous pollutants have been identified, research efforts are shifted to the development of devices and techniques for removing emitted pollutants (retrofit devices) or reducing the initial generation of those pollutants (in-process changes). Health effects research is then initiated to determine the hazardous levels of pollutants on human beings. The specific result of this research effort is the establishment of air, water, and hazardous waste emission standards.

Monitoring research follows, and is primarily concerned with the development of devices and techniques for monitoring point source emissions and the ambient quality of the air and water. Since much research effort in the private sector is devoted to the development of monitoring equipment, research efforts within the Federal Government have generally emphasized monitoring techniques and sampling procedures.

In addition, water quality research will continue with the development of criteria for protection of marine and fresh water fish and other aquatic life. Air quality research and development efforts will concentrate on the effects of pollution through field investigations, regional air pollution models, and epidemiological and toxicological studies of the effects of pollutants on man and animals. Ongoing demonstrations of stack gas treatment technology will be completed and efforts will be directed to long-term technologies relative to the development of clean fuels.

Standard Setting and Enforcement

Table Q–1 shows that outlays for standard setting and enforcement will increase from $368.4 million in 1975 to $416.5 million in 1976. Standard setting and enforcement includes a wide range of activities related to the regulatory efforts of the Federal Government in the area of pollution abatement, but primary emphasis is placed on monitoring, surveillance, standard setting, and enforcement.

Monitoring and surveillance actions refer to Federal agency efforts related to the monitoring of discharged pollutants from point sources and the testing of ambient levels of pollutants, respectively. The accumulated monitoring data is then linked to Federal efforts to develop and review new or existing standards and to the enforcement of those Federal standards. It should be noted that grants to air and water control agencies which have standard setting and enforcement responsibilities are included in the financial assistance data presented in table Q–1.

Pollution Abatement From Federal Facilities

Federal agencies are actively involved in activities to control pollution from their facilities.[1] Outlays for these and other activities to reduce pollution from Federal facilities will increase from $469.3 million in 1975 to $570.7 million in 1976. In general, outlays for pollution abatement from Federal facilities refer to remedial actions, process changes, fuel switching, and their related operating costs.

Remedial actions refer to the placement of retrofit devices on existing facilities or facilities under construction. Retrofit devices treat pollutants after their generation only and are separately identifiable abatement technologies such as dust collectors, electrostatic percipitators, or treatment plants.

Outlays on process changes refer to incremental expenditures for structures or equipment due to the incorporation of pollution abatement features. These process changes reduce or eliminate pollutant emissions by employing material substitution, reuse of waste or water, and equipment or production process alterations. Outlays for fuel switching include the increased costs for fuel and power incurred to reduce pollution (e.g., low sulfur fuel, or increased fuel or power consumption to operate retrofit devices). Operating costs include the costs of cleaning, servicing, and monitoring remedial or process change devices.

Remedial actions continue to be the dominant activity for reducing pollution from Federal facilities (85%). Special attention is currently being given to the construction, or modification, of waste treatment plants, stack gas cleaning on Federal power facilities and joint projects with State and local governments for the disposal of solid or liquid waste. However, as standards become more clearly defined and as technological know-how increases, the use of remedial actions will drop relative to process changes.

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[1] Outlays are for facilities or properties which are either owned or leased by the Federal Government and reflect expenditures on existing facilities, additions to existing facilities or new facilities.

Manpower Development

Outlays for manpower development programs refer to in-house training activities, and fellowships, traineeships, and training grants.

POLLUTION ABATEMENT BY MEDIA

Table Q–2 expresses the Nation's funding for pollution control and abatement by media polluted. Due to grants and loans for the construction of waste treatment plants, water receives the largest share of total Federal pollution control obligations (74.0%). Included in the funding for pollution control and abatement in table Q–2 are activities which directly contribute to the reduction of pollution. Activities which may ultimately lead to abatement and control but are carried on for some other purpose are excluded.

Air and water (other than construction grants) pollution programs include research and development grants to State and local government control agencies and direct Federal operations, such as monitoring, standard setting, enforcement, and reducing pollution from Federal facilities.

Activities relating to the abatement of pollution on land are for research and other studies or demonstration projects concerned with the effects of acid mine drainage, nutrients and pesticides and solid waste disposal. Federal efforts for those selected pollutants shown in table Q–2 are primarily directed toward research relating to effects, control technology, standard setting, and enforcement.

Table Q–2

Pollution Control and Abatement Activities by Media or Pollutant

(In millions of dollars)

Media or pollutant	Outlays 1974 actual	Obligations		
		1974 actual	1975 estimate	1976 estimate
Media polluted:				
Water:				
Construction grants or loans	1,825.6	2,965.0	4,495.9	5,411.5
Other	444.6	499.8	638.3	643.5
Air	328.4	490.1	636.0	531.3
Land	34.3	40.4	46.4	70.3
Other (e.g., living things, materials)	198.4	190.6	359.1	393.4
Multimedia (i.e., more than one of above)	142.9	146.7	194.6	256.7
Total	2,974.2	4,332.6	6,370.3	7,306.7
Selected pollutants:[1]				
Solid wastes	252.5	109.4	130.2	119.7
Pesticides	55.6	64.2	72.9	83.0
Radiation	118.8	121.4	160.5	192.5
Noise	32.3	60.8	57.0	69.9

[1] Funds for selected pollutants are included in "media" distribution above.

POLLUTION CONTROL AND ABATEMENT BY AGENCY

Table Q–3, like table Q–1, shows total Federal funding for pollution abatement and control, but broken down by agency rather than by function. Sixteen agencies reported budget authority and outlays for this category of environmental expenditures for 1976.

MAIN AGENCY ACTIVITIES

The *Environmental Protection Agency* conducts and administers the major pollution control and abatement activities of the Federal Government. Outlays by EPA will increase from an estimated $2,936.6 million in 1975 to $3,079.5 million in 1976. EPA has responsibility over the administration of funding for a major portion of the largest single category of Federal spending

Table Q–3

Pollution Control and Abatement Activities—by Agency

(In millions of dollars)

Agency	Budget authority			Outlays		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Environmental Protection Agency	5,962.6	4,245.8	[1] 742.8	2,032.0	2,936.6	3,079.5
Defense—Military	308.1	325.6	421.1	231.4	309.0	390.6
Energy Research and Development Administration	131.2	187.5	236.2	104.0	150.9	184.9
Transportation	91.6	88.1	96.7	58.8	79.3	98.9
Agriculture	124.9	104.7	118.7	123.1	171.9	166.2
Defense—Civil	8.6	10.3	10.0	8.6	10.3	10.0
Interior	48.0	56.4	65.6	41.1	50.8	57.9
Commerce	66.6	49.8	46.1	58.1	53.1	48.8
National Aeronautics and Space Administration	67.8	65.2	65.1	22.9	55.3	65.9
National Science Foundation	13.4	16.8	13.0	14.3	14.7	15.0
Housing and Urban Development	8.4	9.7	10.1	[2] 154.8	157.5	148.0
Tennessee Valley Authority	3.3	3.4	3.2	[3] 62.1	141.5	171.0
Nuclear Regulatory Commission	54.3	68.7	91.7	54.1	68.7	91.7
Other agencies	6.0	13.0	12.9	8.9	12.9	13.5
Total	6,894.8	5,245.0	1,933.2	2,974.2	4,212.5	4,541.9

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[1] Contract authority for the Environmental Protection Agency's 1976 sewage facility grant program is included as 1975 budget authority since it is allocated and available for obligation in 1975. It therefore appears in the 1975 column for budget authority rather than the 1976 column.

[2] The large difference between outlays and budget authority is primarily due to outlays from budget authority prior to 1974.

[3] The large difference between outlays and budget authority is primarily due to TVA's outlays on remedial action which are funded from revenues rather than budget authority.

for pollution control and abatement, that being grants for constructing or improving municipally owned waste treatment plants.

Research and development will account for 40% of the estimated outlays of EPA's operating programs in 1976. (Construction grants are excluded from operating programs). These funds will be allocated for the study of the processes and effects of pollutants including the health effects of pollutants, their ecological and other nonhealth effects, the movement and transformation of pollutants in the environment, the measurement of pollution problems, and research on low emission fuel-efficient vehicles.

EPA's abatement and control programs apply to a wide variety of environmental problems—monitoring, establishment, and enforcement of standards, issuing of permits and providing technical assistance regarding air, water, solid waste, noise, hazardous materials, and pesticides pollution.

The *Department of the Interior's* Bureau of Mines conducts research and development on procedures to prevent and abate pollution from mining and is attempting to develop improved methods of removing pollutants from mineral processing plants, and for recovering the valuable constituents in mineral processing wastes. It will increase research efforts for methods of converting coal to fuel gas with less pollution.

The *Department of Defense* is expanding its research program to reduce pollution from its industrial production, military, and other facilities. The Corps of Engineers administers a permit program under the Federal Water Pollution Control Act which makes it illegal to discharge dredged or fill material into a navigable water without a permit. The Corps will continue to prepare studies regarding implementation of regional water quality management plans.

The *National Aeronautics and Space Administration* conducts a continuing research and development program to reduce aircraft noise and pollution. NASA is undertaking a major program to develop spacecraft with the capability of detecting and monitoring atmospheric pollution.

The *Department of Commerce* conducts a number of pollution control and abatement activities. Its Economic Development Administration and the Regional Action Planning Commissions provide grants and loans for the construction of water and waste treatment facilities and water and sewer lines where these items are needed to foster economic development. Technical assistance is also provided to solve pollution control and abatement problems. The National Oceanic and Atmospheric Administration is carrying on a broad scale program of equipment installation to further control water pollution resulting from its ship operations. The National Bureau of Standards is engaging in research and development for reference standards and measurement systems for air, water, radiation, and noise pollution.

The *Department of Transportation's* major programs lie in the area of noise pollution control. The Federal Highway Administration is studying techniques to decrease the impact of highway noise, and to control erosion from highway construction. The Federal Aviation Administration is continuing its program to develop quieter aircraft engines. It is also investigating sonic booms, and development of design guidelines for airports so that they are consistent with neighboring land use policies. The Urban Mass Trnasportation Administration will continue support of programs to demonstrate advanced bus and rail technology which reduce pollution and conserve energy. In addition, the U.S. Coast Guard investigates coastal oil spills, and initiates preventive and clean-up actions if the polluter cannot be identified or is not capable of such actions.

The *Department of Agriculture* conducts research on problems of agriculturally related pollution. The Cooperative State Research Service and the Extension Service are continuing to develop methods of reducing pollution from the production and processing of agricultural products. The Forest Service investigates and applies methods of controlling sediment pollution and the Animal and Plant Health Inspection Service conducts programs to reduce the amount of pesticides used to control pests. The Farmers Home Administration makes loans to local organizations to provide for the collection and disposal of human, animal, agricultural, and other wastes in rural areas.

The *Energy Research and Development Administration* (ERDA) is expanding its research relating to pollution sources and effects to assure that rapidly expanding energy technologies currently under development will be implemented with minimal impacts on the environment. Research will also emphasize pilot plant projects for converting coal to fuel gas with less pollution. Prevention and abatement of pollution from mining and the development of improved methods of removing pollutants from mineral processing plants will be continued. Projects aimed at the recovery of valuable constituents in mineral processing wastes will be expanded.

UNDERSTANDING, DESCRIBING, AND PREDICTING THE ENVIRONMENT

Eleven Federal agencies will spend outlays of $1.4 billion in 1976 on activities oriented toward describing the environment, predicting environmental conditions and increasing man's understanding of his role in the broad ecological cycle of which he is a part. Though these activities may ultimately lead to the reduction of pollution, they are not specifically intended for that purpose. Instead, their purpose is to gain a broad understanding of ecological systems and environmental interactions. As such they include efforts toward:

- Observing and predicting weather, ocean conditions, and shock environmental disturbances such as earthquakes. This activity would include the collection of oceanographic and meteorological data, and activities which improve weather monitoring, predicting and warning. Weather satellite programs which will provide enhanced environmental warning services (via an air quality observation network) are also included.
- Locating and describing natural resources. Programs such as the earth resources technology satellite (ERTS) program are helping to better understand existing natural resource systems and also identify, evaluate, and monitor new and existing natural resources.
- Preparing physical environmental surveys of the environment for mapping and charts and related research.
- Weather modification research—includes experiments on weather modification.
- Understanding the impact of man on the environment, and
- Ecological and other basic environmental research—involving the development of baseline data on the abundance and distribution of plants and animals in relation to the modification of the environment by man.

Table Q–4 shows the distribution of both budget authority and outlays by the various functions listed above.

Table Q–5 shows the distribution of total budget authority and outlays shown in table Q–4 by the major agencies involved in this category of activity.

Understanding, Describing, and Predicting the Environment

(In millions of dollars)

	1974 actual	1975 estimate	1976 estimate
Budget authority	1,128.6	1,298.0	1,379.1
Outlays	1,065.3	1,236.2	1,309.3

Table Q–4

Understanding, Describing, and Predicting the Environment—by Function

(In millions of dollars)

Activity	Budget authority			Outlays		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Observe and predict weather ocean conditions, and disturbances:						
Research and development	169.2	172.5	206.6	149.8	153.4	176.6
Operations	340.8	376.8	388.4	334.2	358.2	371.2
Locating and describing natural resources:						
Research and development	142.1	188.6	191.5	120.1	176.2	188.5
Operations	142.9	173.9	187.6	140.1	176.2	183.7
Physical environmental surveys:						
Research and development	14.2	13.3	11.3	15.8	11.2	7.8
Operations	107.3	125.8	121.5	98.6	117.1	115.1
Weather modification research	21.6	22.4	21.1	22.2	23.4	21.5
Research on environmental impact on man	96.7	116.9	129.2	95.7	119.8	130.0
Ecological and other basic environmental research	93.8	107.8	121.8	88.8	100.7	114.9
Total	1,128.6	1,298.0	1,379.1	1,065.3	1,236.2	1,309.3

AGENCIES INVOLVED

Department of Transportation research will focus on making transportation facilities compatible with the environment, and on conserving energy through more efficient use of existing transportation resources. The Coast Guard collects oceanographic and meteorological data for the preparation of maps and charts to be used in the development of ocean transportation. FAA activities are devoted to an understanding of adverse environmental effects of aircraft noise, pollution, and sonic booms. The agency will continue work on a multiyear, multimillion dollar research program on the effects of engine exhaust on the stratosphere.

Research by the *Department of Housing and Urban Development* includes analyses to increase knowledge of the effects of urban and nonurban change, particularly as it affects and is affected by the natural environment.

The *Smithsonian Institution* develops environmental baseline data on the abundance and distribution of plants and animals in relation to modification of the environment by man. It also identifies indicator organisms that can be used in monitoring the environment.

In the *Department of Commerce,* the National Oceanic and Atmospheric Administration conducts a wide range of environmental monitoring and prediction activities, weather modification experiments, surveys for mapping

Table Q–5

Understanding, Describing, and Predicting the Environment—by Agency

(In millions of dollars)

Agency	Budget authority			Outlays		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Commerce	330.9	369.8	383.9	329.9	354.3	346.3
Defense—Military	151.1	163.5	165.8	135.4	140.5	145.6
National Science Foundation	112.4	120.4	139.9	105.9	113.2	126.4
Interior	162.2	233.9	246.7	151.2	229.2	240.1
National Aeronautics and Space Administration	116.8	115.4	128.2	89.3	100.8	118.6
Agriculture	113.8	129.6	133.7	114.5	132.9	133.2
Energy Research and Development Administration	65.2	87.3	101.0	64.8	85.8	100.8
Health, Education, and Welfare	28.4	28.0	28.1	27.9	31.3	29.4
Transportation	18.2	14.6	16.5	18.0	14.0	15.9
Smithsonian Institution	11.1	12.8	12.3	10.3	12.1	12.5
Other agencies	18.5	22.7	23.0	18.1	22.1	22.5
Totals	1,128.6	1,298.0	1,379.1	1,065.3	1,236.2	1,309.3

and charting, data archiving and dissemination services, and related research. Continued emphasis will be given to improving weather monitoring, prediction, and warning to help further reduce the loss of life and property from natural disasters. Increased outlays in 1976 will support improvement of weather prediction and warnings through better basic observations. This program will concentrate on procedures to modify FAA radar equipment in mountainous areas to insure continued availability of weather data from these sites. The weather satellite program will provide enhanced environmental warning services and will prepare for the next generation of polar-orbiting satellites. Implementation of the air quality observation network will be continued as will coastal zone research.

The *Department of Health, Education, and Welfare,* through the National Institute of Environmental Health Sciences, conducts research directed at the identification of chemical, physical, and biological environmental factors which affect human health.

The *Department of Defense* conducts activities in environmental observation and measurement to describe and predict weather, ocean conditions, and disturbances important to military operations. Research is conducted in oceanographic instrumentation development and operational systems for observing and forecasting the ocean environment. The Corps of Engineers conducts hydrologic studies as a background for future use in optimum design, construction, and operation of water control structures. The Corps also examines the effects of construction on coastal ecology in order to permit more accurate assessment of the ecological effects of offshore construction and dredging.

The *National Science Foundation* supports environmental research with the objective of increasing the Nation's knowledge base in order to improve environmental management. Studies are undertaken in all aspects of the biosphere on an environmental systems basis. Efforts will continue to measure and assess the environmental effects of mining, manufacturing, use, and disposal of metallic and synthetic organic compounds.

In the *Department of Agriculture,* the Agriculture Research Service conducts research by remote sensing to study animals in a natural environment, crop conditions and insect infestations, and soil-water-plant conditions in order to improve both animal and crop production. It is also increasing its efforts to monitor and understand the ecological patterns of disease and insects in order to develop an integrated pest management program which would reduce the use of pesticides.

The Forest Service studies forest ecosystems so that policy decisions and management practices can lead to improved productivity while maintaining the quality of the environment. The Soil Conservation Service conducts soil and snow surveys, and makes water supply forecasts.

The *Department of the Interior* supports research conducted by the Bureau of Reclamation on weather modification, water salinity problems, and the effects of water resource development projects on ecology and limnology.

The National Park Service conducts natural science ecological studies leading to improved resource management and proposals relating to impact of development on the park environment while the Office of Water Resources Research sponsors and provides for the conduct of research, investigations, and experiments in the water resources field.

The *National Aeronautics and Space Administration,* through its use of satellites, has developed a number of programs with the potential of making accurate short-term (a few hours) weather predictions, and accurate long-term (2 weeks) weather and climate predictions. In addition to helping to better understand natural resources systems, the ERTS program is used for identifying, evaluating, and monitoring animal and plant habitats and distributions, water and vegetation distribution, surface moisture, and the effect of thermal and particulate pollution on the ecology and environment.

The *Energy Research and Development Administration* (ERDA) will direct research toward the siting problems of powerplants in fulfillment of the requirements of NEPA. Further information will be gathered on the biological effects of thermal effluents on various aquatic ecosystems; the effects (by nuclear powerplants) of various attrition rates of larvae fishes on the ability of adult fishes to maintain themselves; the overall effects of various alternative methods of cooling water disposal; and the toxicity of various chemicals added to cooling systems to prevent biological fouling.

ENVIRONMENTAL PROTECTION AND ENHANCEMENT

Activities within this category place emphasis on enabling man to use and enjoy the outdoor environment through the provision of recreational facilities, parks and open areas. In 1976, $1.1 billion will be spent on this type of planning for conservation and management of wildlife and fishery resources.

The achievement of these goals is accomplished by both direct Federal expenditures and by grants to State and local governments. Direct Federal programs are primarily directed toward providing for the acquisition of land in order to preserve nationally unique natural areas and supporting sport fish and wildlife preservation. State and local governments use grant funds to acquire and develop land for recreational purposes and to preserve local fish and wildlife refuges.

Table Q–6 shows the distribution of Federal funding across the major program areas within this category. It also shows the allocation of total funds between direct Federal activities and grants to State and local governments.

Table Q–6

Environmental Protection and Enhancement—by Function

(In millions of dollars)

Activity	Budget authority			Outlays		
	1974 actual	1975 estimates	1976 estimates	1974 actual	1975 estimates	1976 estimates
Financial aid to State and local governments:						
Purchase, development and operations:						
City recreation	35.6	50.9	49.8	[1]93.1	106.5	92.4
Preserve unique areas	.2	.2	2.5	[1]25.0	23.5	25.8
Noncity general recreation	59.0	141.5	147.0	120.8	123.4	135.9
Sport fish and wildlife	75.0	85.0	89.4	67.8	82.7	85.8
Historic preservation and rehabilitation	11.6	20.1	20.1	11.4	16.9	20.0
Other State and local aid	12.1	13.4	22.0	14.9	29.7	50.1
Subtotal	193.5	311.1	330.8	333.0	382.7	410.0
Direct Federal activities:						
Purchase, development and operations:						
City recreation	103.2	137.8	117.0	108.1	120.9	113.4
Preserve unique natural areas	130.8	168.6	210.5	151.0	136.0	182.8
Noncity general recreation	127.0	184.9	180.2	128.2	178.5	178.5
Sport fish and wildlife	60.8	72.1	70.0	61.6	64.5	67.3
Historic preservation and rehabilitation	37.0	66.6	55.2	40.6	51.8	45.7
Other direct activities	49.8	72.8	72.7	47.6	74.6	71.8
Subtotal	508.6	702.8	705.6	537.1	626.3	659.5
Total	702.1	1,013.9	1,036.4	870.1	1,009.0	1,069.5

[1] See footnote at bottom of Table Q–7.

As indicated in table Q–6 the major environmental protection and enhancement activities are:

- City recreation—including direct Federal involvement or Federal financial assistance for projects which establish or develop parks and recreational facilities in urban areas;
- Preservation of unique national areas which includes programs related to national parks, monuments, scenic rivers, trails, wildernesses, seashores, and wildlife refuges;
- Noncity general recreation programs including those for recreation in nonurban areas such as national forests and Federal water projects;

- Sport fish and wildlife projects which create and manage wildlife, refuges, fish hatcheries, and protect rare and endangered species; and
- Historic preservations and rehabilitation of national historic sites and military parks.

Table Q–7 illustrates the distribution of funds in this category by agency.

AGENCIES INVOLVED

The *Department of the Interior,* through its Bureau of Land Management, protects and manages over 450 million acres in the Western States and Alaska, representing 20% of America's land base. Legislation has been proposed that would establish as national policy, that these resource lands be managed under principles of multiple use and sustained yield in such a way as to protect the quality of the environment.

The Bureau of Outdoor Recreation promotes the coordination of outdoor recreation programs, and administers the Land and Water Conservation Fund which provides grants for planning, acquisition, and development of State and local recreation areas and Federal purchases of nationally important lands.

The Fish and Wildlife Service provides assistance to State and local governments for fish and wildlife restoration, management, and research. The Service administers 95 hatcheries and 356 units in the National Wildlife Refuge System containing 30.7 million acres. Endangered species are protected on 82 of the national wildlife refuges.

The National Park Service administers 308 areas comprising about 29 million acres located in 47 States, the District of Columbia, Puerto Rico, and the Virgin Islands. These include national parks, monuments, historic sites, and other areas which have been established to preserve the Nation's natural and historic heritage.

In the *Department of Commerce,* the National Oceanic and Atmospheric Administration is placing emphasis on improved management of the Nation's coastal zone through federally assisted and coordinated State programs. In 1976, NOAA will continue to provide grants to States for the preparation of their coastal zone management plans and the initial phases of administration of those plans. Other activities in 1976 will provide for administration and enforcement of the Marine Mammal Protection Act of 1972, research on the

Table Q–7

Environmental Protection and Enhancement—by Agency

(In millions of dollars)

Agency	Budget authority			Outlays		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Interior	498.0	797.6	803.7	606.4	682.0	733.0
Agriculture	88.2	92.1	101.6	84.0	99.6	97.2
Defense—Civil	54.5	77.3	77.8	54.5	72.8	82.0
Commerce	35.5	38.6	44.8	24.0	38.3	38.4
HUD	(1)	(1)	(1)	92.7	90.6	110.6
Other agencies	25.9	8.3	8.5	8.5	25.7	8.3
Total	702.1	1,013.9	1,036.4	870.1	1,009.0	1,069.5

[1] Outlays are from budget authority prior to fiscal year 1974.

status of stocks of whales, and research on fur seals. Research on aquaculture and grants to States for the enhancement and restoration of the marine fishery resources will be continued.

The *Department of Agriculture* carries out a variety of enhancement activities, particularly through the Forest Service. The 187 million acres of national forest lands are managed in accordance with the provisions of the Multiple Use-Sustained Yield Act to provide outdoor recreation, range, timber, watershed, mineral, and wildlife values in combinations that will best protect resources without impairing the productivity of the land.

RESEARCH AND DEVELOPMENT

Significant funding of environment-related research and development will continue in 1976. Research and development programs exist under both the pollution control and abatement and the understanding, describing, and predicting categories.

Table Q–8

Environmental Research and Development Activities

(In millions of dollars)

Category	Budget authority			Outlays		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Pollution control and abatement [1]	506.2	713.4	710.4	414.5	581.3	683.6
Understanding, describing, and predicting	537.6	621.6	681.6	492.4	584.7	639.3
Total	1,043.8	1,334.9	1,392.0	906.9	1,166.0	1,322.9

[1] Includes both primary and secondary research and development.

APPENDIX G

ADVISORY COMMITTEES OF THE COUNCIL ON ENVIRONMENTAL QUALITY

In addition to the Presidentially appointed Citizens' Advisory Committee on Environmental Quality, the Council has appointed the Advisory Committee on Alternative Automotive Power Systems. As required by Executive Order 11007, the members, a brief description of their functions, and the dates of their meetings are listed below.

CITIZENS' ADVISORY COMMITTEE ON ENVIRONMENTAL QUALITY

FUNCTIONS

Established by Executive Order 11472, May 29, 1969, this committee advises the President and the Council on Environmental Quality on all aspects of environmental quality and recommends actions by federal, state, and local governments and by the private sector. The Council consults with the Committee pursuant to section 205 of the National Environmental Policy Act (42 U.S.C. § 4345).

CHAIRMAN

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Washington, D.C.

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Los Angeles, Calif.

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Washington, D.C.

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Arthur Godfrey Productions
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President
Northeast Utilities
Hartford, Conn.

Mrs. Thomas Waller
Bedford Hills, N.Y.

Mayor Pete Wilson
San Diego, Calif.

MEETINGS

September 29–30, 1974, Madison, Wisconsin
February 14, 1975, Washington, D.C.
May 30, 1975, Washington, D.C.
September 29, 1975, Washington, D.C.

ADVISORY COMMITTEE ON ALTERNATIVE AUTOMOTIVE POWER SYSTEMS

FUNCTIONS

The Committee advises the Council on research and development programs and other technical progress toward developing low-emission, surface-vehicle power systems as alternatives to the present internal combustion engine.

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Dean of Engineering
University of Michigan
Ann Arbor, Mich.

EXECUTIVE SECRETARY

Saunders B. Kramer
Environmental Protection Agency
Ann Arbor, Mich.

MEMBERS

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Vice President, Engineering
McCulloch Corporation
Los Angeles, Calif.

Dr. S. William Gouse
Director, Office of Research and Development
Department of the Interior
Washington, D.C.

Jack I. Hope
General Manager
General Electric Company
Cincinnati, Ohio

Dr. George J. Huebner, Jr.
Director of Research, Product Planning and Development
Chrysler Corporation
Detroit, Mich.

David F. Moyer
Director, Systems Research Laboratory
Ford Motor Company
Dearborn, Mich.

Professor Robert F. Sawyer
Department of Mechanical Engineering
University of California
Berkeley, Calif.

Ernest Starkman
Vice President, Environmental Activities Staff
General Motors Technical Center
Warren, Mich.

Dr. John H. Sununu
Associate Dean, College of Engineering
Tufts University
Medford, Mass.

GOVERNMENT LIAISON MEMBERS

Dr. John A. Belding
Advanced Energy Research and Technology Division
National Science Foundation
Washington, D.C.

William Dickinson
Deputy Director, Environmental Policy Analysis Division
Federal Energy Administration
Washington, D.C.

Robert English
Chief, Power Systems Division
National Aeronautics and Space Administration
Cleveland, Ohio

Lewis Gerlach
Chief of Transportation Research
U.S. Postal Service
Washington, D.C.

Dr. William Kirchoff
Deputy Manager, Measures for Air Quality
National Bureau of Standards
Washington, D.C.

Lawrence W. O'Connell
U.S. Atomic Energy Commission
Washington, D.C.

Dr. Ernest N. Petrick
Chief Scientist
U.S. Army Tank-Automotive Command
Warren, Mich.

George W. Saunders
Assistant Commissioner for Motor Equipment
Transportation and Public Utilities
General Services Administration
Washington, D.C.

Eric O. Stork
Deputy Assistant Administrator
Mobile Source Air Pollution Control
Environmental Protection Agency
Washington, D.C.

Dr. Richard L. Strombotne
Assistant for Physical Sciences, Systems Development, and Technology
Office of the Secretary
Department of Transportation
Washington, D.C.

MEETINGS

November 3–8, 1974, Dusseldorf, Federal Republic of Germany
February 13–14, 1975, Washington, D.C.

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